1920.

VICTORIA.

DEPARTMENT OF MINES.

RECORDS

OF THE

GEOLOGICAL SURVEY OF VICTORIA

(H. HERMAN, B.C.E., M.M.E., F.G.S., Director).

Vol. IV., Part 2.

ISSUED BY

W. DICKSON, SECRETARY FOR MINES, UNDER THE AUTHORITY OF THE HON. S. BARNES, M.L.A., MINISTER OF MINES.

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CONTENTS.

LIMESTONE AT ARINGA, NEAR PORT FAIRY.

By W. H. Ferguson, Assistant Field Geologist.

The limestone dealt with in this report is situated on the Aringa estate, about 5 miles westerly from Port Fairy.

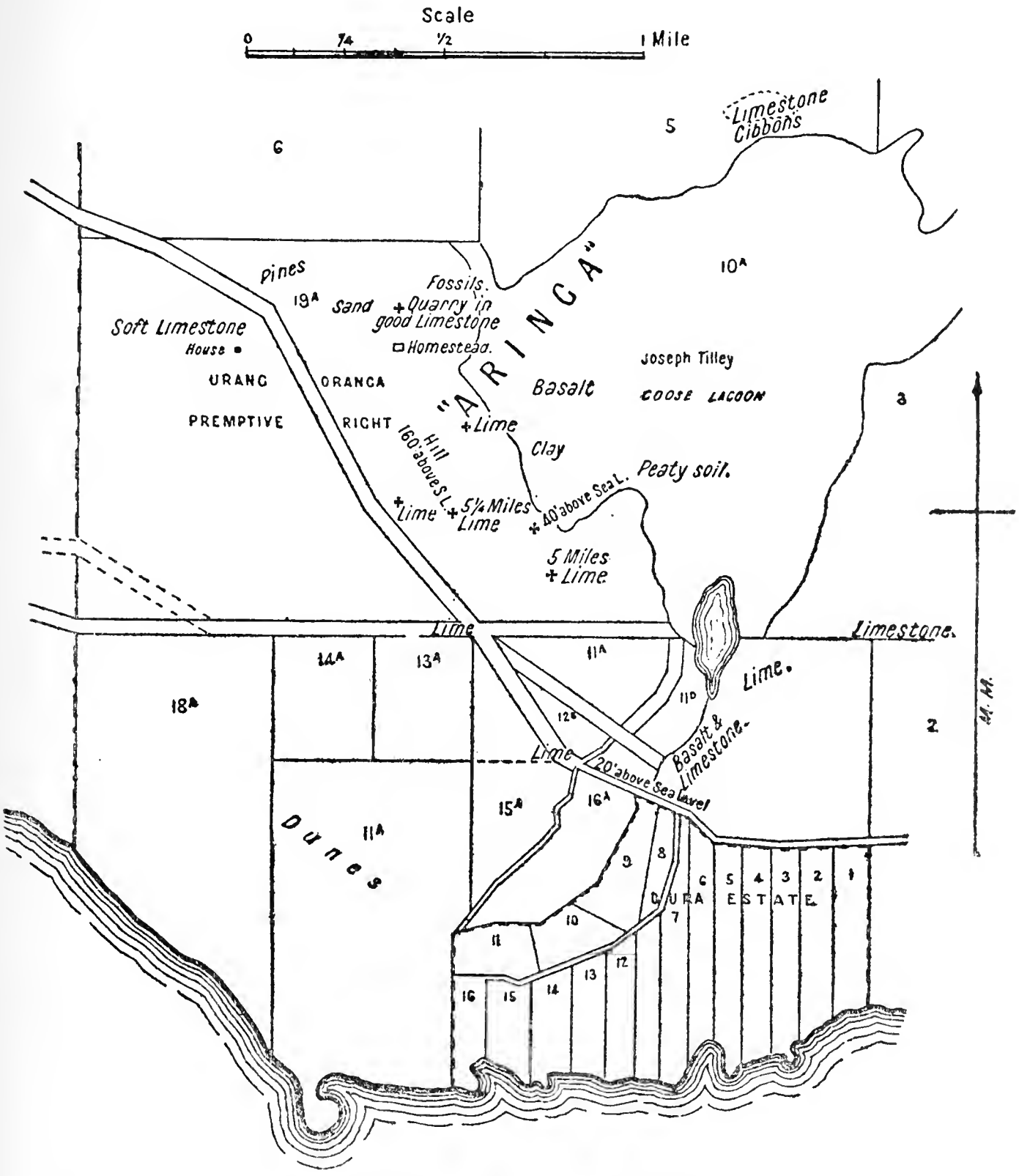


FIG. 36.—Plan of Portion of Parish of Aringa, showing Limestone Deposits.

A large quantity of limestone of varying quality extends in a westerly direction from Port Fairy. Some of it is dune limestone of recent to Post Pliocene age, and other parts consist of fossiliferous marine limestone, probably of Jan Jukian or Miocene age. The dune stone is mostly light, soft and porous, and white in colour. The Miocene limestone is in places dense, solid, and pale-brown or creamy in colour; in other places it is lighter and more friable. The dune limestones appear to rest on a flow of newer volcanic basalt, but the relation of the Miocene limestone to the other formations of the locality was not investigated.

Mr. Tilley (the owner of Aringa station) pointed out the various outcrops of limestone, clay, and sand on his property. Good dense stone was noted in the small quarry in the Woolshed paddock; at a depth of 20 feet in the well at the homestead; at the shaft on the hilltop; at about 5 and 5¼ miles respectively from Port Fairy; at Gibson's; and some stone which was somewhat more friable at the Middle paddock. The positions are marked on the accompanying parish plan. (Fig. 36.)

Seven samples of limestone were submitted to the Geological Survey laboratory for partial analysis. The following are the results:—

Locality.	Sample No.	$CaCO_3$ Carbonate of Lime.
		%
Quarry in Woolshed paddock	198	94·8
Well 20 ft. deep, Aringa homestead	199	74·8
Hole, 5¼ miles west of Port Fairy	200	89·7
Hole, 5 miles west of Port Fairy	201	93·4
Gibson's outcrop	202	96·1
Middle paddock, Aringa	203	86·5
Syndicate's shaft, Aringa	204	92·9

The samples contain also small amounts of magnesia, silica, iron, alumina, and traces of phosphoric acid. Except No. 199, all contain sufficient lime for cement.

On the flat, about 1 mile east of the homestead, there is a bed of black, very tough clay. It is a surface layer, and Mr. Tilley informs me that it is 4 feet thick. It extends over many acres. A sample was submitted to the Geological Survey laboratory with the following results:—

No. 206. This sample, which came from 1 mile east of Aringa homestead, where a syndicate once had an option over 10 acres, consists of a very plastic clay, impregnated with organic matter, to which is due its blackness. It contains 10 per cent. of sand grains, which are retained on the 100 mesh sieve after washing. This renders it unfit for use as a cement-making material. By grinding, the clay would become suitable for cement, but this would add to the cost.

Without boring, the thickness of the limestone series could not be accurately determined, but apparently there is abundance of stone. On the Aringa estate, limestone of varying quality, which in places is covered by sand, outcrops in many places at the surface, and extends from south-east to north-west for 1½ miles, showing for over a quarter of a mile in width. The surface varies approximately from 20 ft. to 100 ft. above sea level. In a number of places good solid layers of limestone 6 ft. to 10 ft. thick were observed. The quantity of limestone cannot be estimated from the available data, but it must be considerable.

A small area of good limestone was noted 1 mile north-easterly from the homestead; this is known as Gibson's. It covers about 6 acres, and is just above the level of the flat. Possibly 30,000 tons of limestone could be obtained here, to a depth of 6 or 7 feet.

The crystals in the peaty soil from the flat at Gibson's consist of gypsum. These minute crystals, mixed with the peaty soil, may be of use as a fertilizer.

LIMESTONE AT GARVOC.

By L. H. Ower, Assistant Boring Engineer.

The erosion of the Mt. Emu Creek has exposed a number of outcrops of marine Tertiary limestone, underlying a thin capping of basalt. The prospecting hole has been sunk on a low tongue of land in allotment 12, parish of Laang, about 1 mile south from the Garvoc railway station.

The limestone can be traced at intervals, where the soil has been denuded, along the creek frontage, from which it may be assumed that the deposit is extensive and of considerable depth. The rock is mainly of a hard compact character, samples assayed at the Geological Survey laboratory showing 93 per cent. of carbonate of lime.

Sufficient information is to hand to enable quarrying to be commenced immediately, and the best position for opening out is in the vicinity of the present prospecting hole.

A basalt overburden will have to be removed as the quarry advances, but it is not likely to cause serious trouble.

[15.10.13.]

REPORTED OCCURRENCE OF BLACK COAL NEAR CURDIE'S SIDING.

By H. Herman, M.M.E., F.G.S., Director, Geological Survey.

The site where good black coal is reported to occur near Curdie's Siding is that of an old sawpit, in Block 46, parish of Brucknell, county of Heytesbury, about 28 chains east of the parish boundary road, about 5 chains from the west boundary of the block, and about 30 chains southerly from the northern boundary.[1] About twenty years have elapsed since the pit was working, and from the excavation then made several barrow-loads of black coal were obtained from a depth of about 4 ft., according to Mr. Tranter, who states that he saw the coal taken out. The coal is stated to have been burned on the forge for several weeks and used for sharpening tools. Mrs. Tranter informed me that at the time she sent a sample in her own name to Mr. James Stirling (then Assistant Government Geologist), and received in reply an analysis stating that the coal was high grade black coal (or to that effect) and contained only 3 per cent. of ash. Mr. Stirling's report also, she states, expressed the opinion that "the main seam is 60 to 160 ft. from the surface." The analysis and report are not now in Mrs. Tranter's possession.

Last year Mr. Frank Tranter bored 55 ft. deep at about 20 ft. distant from the pit where the coal is stated to have been obtained, and his records (given verbally) of material passed through are about 10 ft. of loam and sandy clays, then 8 ft. of white hard limestone, then about 30 ft. of "grey pug;" thence a white loose powdery material to the bottom.

A hole a few feet from the pit shows limestone a few feet from the surface. There is little doubt that this limestone belongs to the marine Lower or Middle Tertiary series of the district, and a seam of good black coal overlying it, and evidently included in the marine series, would be distinctly a geological freak. The facts that the bore did not pass through

[1] Mr. Frank Tranter supplied these figures.

coal and that no more coal has been found by excavating to a depth of 4 ft., also furnish strong reason for doubting the authenticity of the alleged occurrence, which should not be regarded seriously in the absence of further strong direct evidence.

[29.1.13.]

MATRIX REEF, McINTYRE'S.

By E. J. Dunn, F.G.S., late Director, Geological Survey.

The site of McIntyre's diggings is 2½ miles south from Rheola, formerly the scene of the famous Berlin rush, and a noted locality for large nuggets, two of which (the largest found) each weighed over 68 lbs. These were obtained immediately below where the rich shoot now being worked on the Matrix Reef cropped out at the surface. McEvoy and his two mates are said to have secured over £20,000 worth of gold from the outcrop of the shoot of gold.

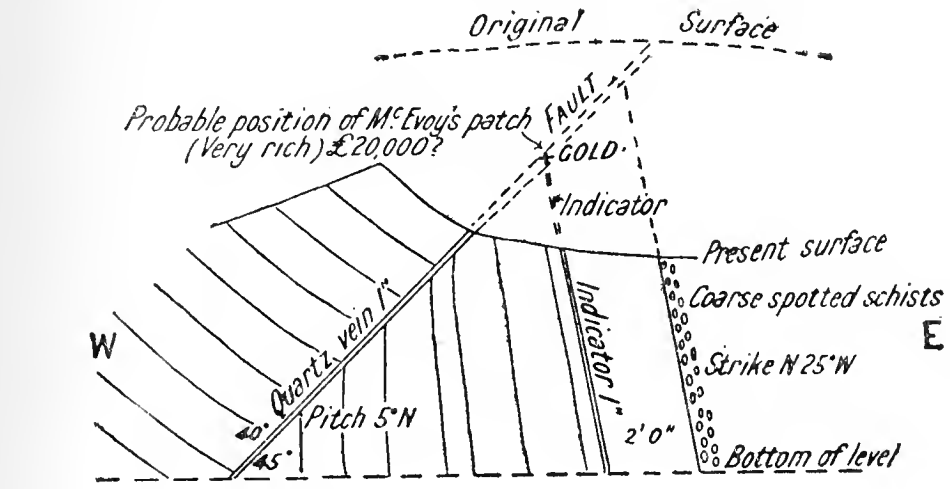
The country rock consists of highly altered, fine nodular schist and other beds that have been changed through the proximity of granite. This rock crops out a few chains east of the workings on Matrix Reef, and would probably be met with in from 300 to 400 ft. below the workings. The strike of the schist, &c., is about N. 25° W., and the dip, on the east side of the fault, where a quartz vein occurs, is easterly at from 75° to 80°.

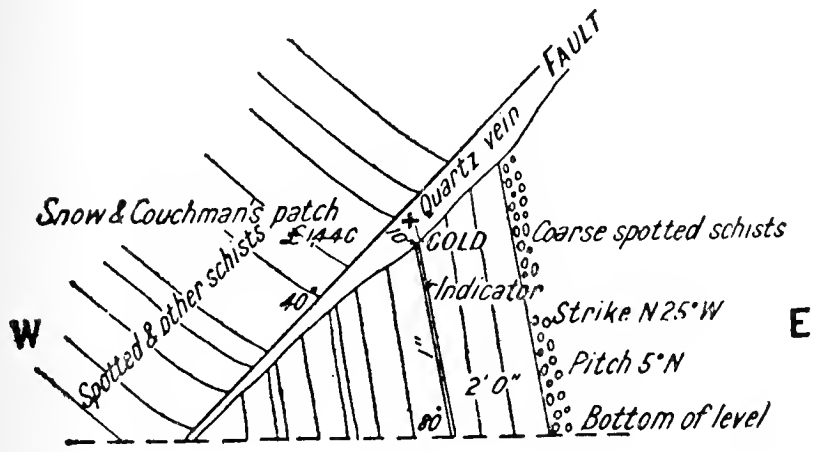
The prominent feature at this locality is that one of the beds in the schist is an indicator; it is about half-an-inch thick, and alongside of it is about half-an-inch of quartz. The indicator under the lens appears to be a fine siliceous sandstone, through which fine crystals of iron pyrites were thickly disseminated, represented now by casts with some ferruginous matter. The indicator is of bluish-grey colour. Along the course of the indicator all the gold obtained so far has been found where it is intersected by a fault dipping west at 45°. The fault is filled by a quartz vein from 1 in. to 12 in. thick, and the gold is in this vein at and near where it intersects the indicator and along the line of intersection. The pitch of the intersection of the quartz vein and indicator is northward about 5° at the mouth of the tunnel and 10° near the present north end of the tunnel. This angle of pitch was set out by the writer for Messrs. Snow and Couchman, and it has been driven on for 400 ft. by Dr. McDonald and O'Brien's party, and several patches of gold have been obtained amounting altogether to over £4,000 in value, won by two men in about three years. The last crushing just completed returned 435 oz. smelted gold from 57 tons of quartz.

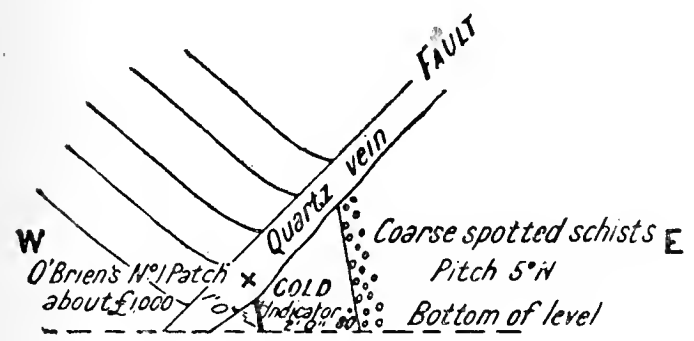
The workings on the Matrix Reef show the exact conditions under which the large nuggets were formed, and the success so far obtained should stimulate further search for other rich indicators and for further gold shoots on this one.

From the position in which the alluvial gold and nuggets in No. 1 and No. 2 Gullies were found, it is evident that there are other shoots along this line that have supplied gold abundantly to the alluvial ground. One shoot should be sought further north than the one being worked, and another further south above the school-house in No. 1 Gully. It is also noticeable that going south from the school-house the continuation of the Matrix Reef strike skirts the alluvial ground which runs towards the St. John's patch, the alluvial appearing to originate along that line.

Most of the nodular schists are fine grained, but just two feet to the eastward of the indicator there is a bed of much coarser nodular schist, which forms a good guide as to the position of the indicator.







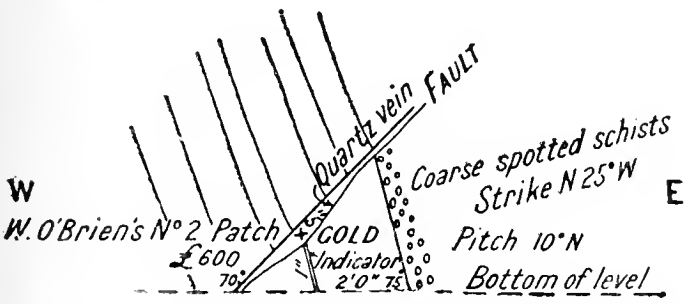


FIG. 37.—Transverse Sections, showing the Matrix Reef and Indicator.

(Scale—8 feet to 1 inch.)

It is clear in the present case that the indicator has exercised a direct influence in causing the deposition of the gold, for it is only within a few inches of the intersection of the indicator by the quartz reef that gold is found. The gold is not of secondary character in the quartz vein, but was deposited at the same time as the quartz. It is of high quality, worth £4 3s. per oz. and ranges from very fine particles to half-ounce pieces. In the richer portions the quartz is held together by the gold. Felspar occurs fairly abundantly in some portions of the quartz, no doubt resulting from the proximity of the granite, and particles of gold are to be seen in some of the felspar.

In prospecting, the indicator must be followed closely; and, wherever a quartz vein is found to intersect it, there is a chance of finding gold. As in many other cases, the indicator dips to the east, where it has proved to be so productive. In this district there is ample scope for prospectors who are qualified to follow up these indicators, but as the gold only occurs alone certain lines and at certain intersections, considerable experience is needed if success is to be obtained.

BASS AND WATSON'S GOLD WOLFRAM MINE, LINTON.

By H. Herman, M.M.E., F.G.S., Director, Geological Survey.

On 24th of March last, I inspected Bass and Watson's workings at Linton, where a number of shafts as per plan attached (Fig. 38) have been sunk on a quartz lode containing gold and wolfram.

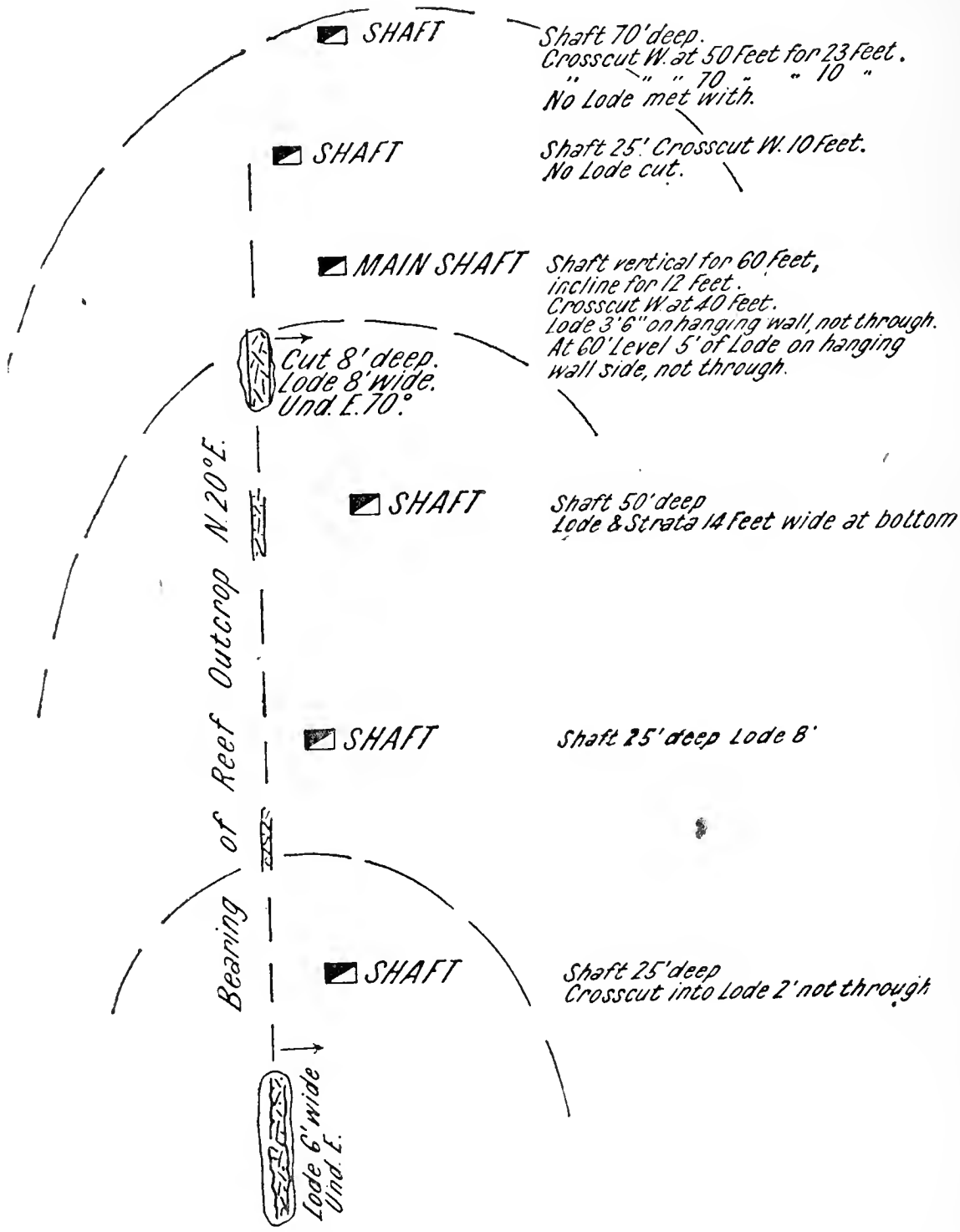


FIG. 38.—Sketch Plan, showing Shafts and Reef Outcrop, Bass and Watson's Gold-Wolfram Workings at Linton.

(Scale—80 feet to 1 inch.)

The prospectors' main shaft was sunk to a depth of 60 ft. vertical, where, the lode being cut, an underlie was put down along the hanging wall a further 12 ft. (Fig. 39). At 72 ft. a drive was put in south for 15 ft., where a rise broke through into Tibbett's workings of 1865. In the south drive the lode was crossed and proved to be 5 ft. wide. At the surface the outcrop was 15 ft. west of the shaft, the lode here being 8 ft. wide. At the 40 ft. level the hanging wall was cut at 6 ft. to the west and carried a lode 3 ft. 6 in. wide, with mullock on the west side separating it from another body of quartz which was cut into for 4 ft. At the 60-ft. level a width of 5 ft. of solid stone shows on the hanging wall side, but the full width is not proved.

In a shaft 33 ft. north of the main shaft, a cross-cut west for 10 ft. was put in at a depth of 25 ft., but failed to locate any lode; the centre of this shaft is only 10 ft. east of the line of lode outcrop. At 1 chain north of the main shaft a third shaft was sunk to a depth of 70 ft. At 50 ft. a cross-cut was driven west 23 ft., showing no stone. At 70 ft. a cross-cut west was driven 10 ft., also without result. South of the main shaft at 10 ft. the outcrop of the lode is 8 ft. wide and dipping to the east.

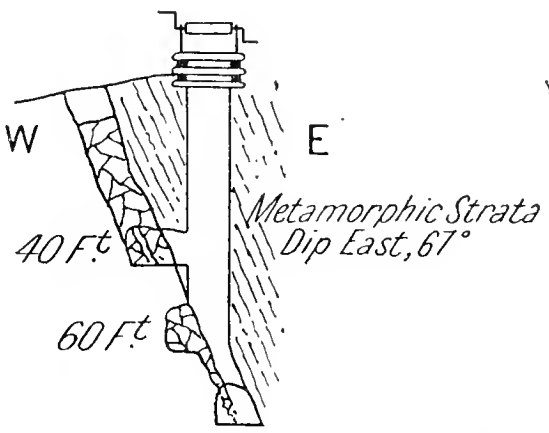


FIG. 39.—Transverse Section, Prospectors' Main Shaft.
(Scale—80 feet to 1 inch.)

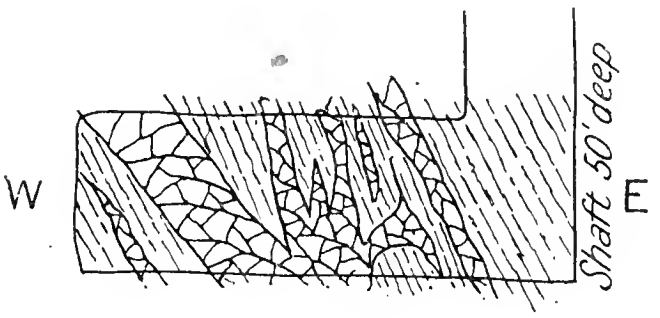


FIG. 40.—Cross-cut from Bottom of Fourth Shaft.
(Scale—16 feet to 1 inch.)

At 1 chain south of the main shaft a fourth shaft 50 ft. deep shows a lode 14 ft. wide at the bottom (Fig. 40). At 2 chains south of the main shaft a reef 8 ft. wide was cut at a depth of 25 ft. in a fifth shaft. At 3 chains south of the main shaft, in a sixth shaft, at a depth of 25 ft., the reef was cut into for 2 ft., but work here ceased before the width of the lode was proved. At 20 ft. further south the lode, in an open cut, shows a width of 5 ft. of solid quartz for a length of 30 ft.

Samples for assay were obtained from:—

1. North face of Tibbett's old drive at a depth of 60 ft. (this face is about 8 ft. from the main shaft). Lode 5 ft. wide, only the footwall portion is exposed.
2. South face of the 70 ft. level (main shaft) at 12 ft. south. Lode 5 ft. 6 in. wide.
3. At the 60 ft. level in main shaft. Sample taken of 5 ft. of the hanging wall portion of the lode.
4. Two samples taken 5 ft. apart at the 40 ft. level on the north side of main shaft at 3 ft. and 8 ft. distant respectively. Lode 3 ft. across, with more quartz on the footwall side.
5. From the cross-cut, shown in Fig. 40, at bottom of shaft, 1 chain south of main shaft. Lode and schist taken 14 ft. wide.
6. From trench on ironstone—tourmaline outcrop several chains southwards from the main shaft.

The values obtained by assay were as shown in Mr. P. G. W. Bayly's report attached (see Amalgamation and Cyanide Tests, page 113.)

I have been furnished by Mr. J. A. Dawson, of Snake Valley, with returns of several parcels of ore sent for bulk treatment to various works. These were:—

(*a*) 10 cwt. 1 qr. of picked stone treated in October, 1912, at Edward's metallurgical works, Ballarat, gave 7 dwt. of gold per

ton and 9.5 per cent. of wolfram. The parcel was paid for at £4 4s. 6d. nett; the contents being valued, per ton, at £9 3s. 2d. for wolfram, and £1 8s. for gold.

(*b*) 6 tons treated in December, 1912, at Edward's works yielded 7 dwt. 12 gr. of gold per ton; wolfram, nil.

(*c*) 4 tons 15 cwt. purchased in January, 1913, at Edward's works, contained value per ton of 16s. for gold, and £1 13s. for wolfram.

(*d*) 4 cwt. of picked wolfram stone treated at Jacques, Fisher and Company's works, Melbourne, returned 14 per cent. of wolfram concentrates, assaying 56.6 per cent. of tungstic acid, and 1 oz. 11 dwt. per ton of gold.

(*e*) 8 cwt. treated at Edward's works yielded per ton wolfram 13s., and gold 7 dwt.

(*f*) 5 tons treated in October, 1913, at the School of Mines, Ballarat, showed by assay 7 dwt. 3 gr. of gold and 3.8 per cent. of tungstic acid. Actual extractions were 127 lb. of wolfram concentrates in all, and 2 dwt. 23 gr. of gold per ton. Amalgamation was not used in the battery except for the concentrates, and the tails contained 4 dwt. of gold per ton. The report states that the tailings can be easily cyanided. The gold extracted (14 dwt. 18 gr.) sold for £2 19s. 2d.—equal to £4 1s. per oz.

(*g*) 5 tons 2 cwt. 3 qr. 16 lb. treated at the School of Mines, Ballarat, assayed 5 dwt. of gold per ton, and yielded 3 cwt. of concentrates in all. The tails contained 2 dwt. 16 gr. of gold per ton, 2 dwt. 8 gr. being extracted. The treatment was the same as for (*f*).

(*h*) 6 tons 8 cwt. treated in October, 1913, at Edward's works contained 7 dwt. of gold per ton, and 0.5 per cent. of tungstic acid.

Mr. Dawson informed me that the above parcels were taken from the 40-ft., 60-ft., and 70-ft. levels of the main shaft, and represent practically the whole of the stone extracted; also that, excepting for the wolfram tests, the stone was not picked.

Various samples sent by the owners for assay at the Geological Survey laboratory—the particulars of the localities given and the sampling are those of the owners themselves—assayed as follows:—

Laboratory Number.	Locality.	Per Ton of Sample.						Tungstic Acid WO_3.
		Gold.			Silver.			
1912.		oz.	dwt.	gr.	oz.	dwt.	gr.	%
469	From 1 ton at surface ..	0	9	3	0	4	14	14·5
470	From footwall, surface	1	4	12	0	3	22	0·15 (Small amount of bismuth)
545	From 40-ft. level ..	0	5	6	0	1	15	31·68
601	From 60-ft. level ..	0	6	12	0	2	5	4·30
602	From 40-ft. level ..	0	7	20	0	2	5	—
607	From 40-ft. level ..	0	15	16	0	3	6	20·7 (Bismuth, 1·27)
1913.								
703	At 25 ft. deep, 80 ft. south of main shaft	0	17	15	0	1	23	Very small amount of wolfram and bismuth

On the assays obtained of samples taken by myself, the lode is certainly worth further systematic work. Although these samples contain little wolfram, it is quite likely that the mineral occurs in pockets, and

usual sampling methods would be apt to miss them. Nevertheless I think that it is preferable to regard the lode primarily as a gold lode, and that if a treatment plant should be erected later on it should simply be a gold mill of the usual type, with concentrators of the Wilfley or Card type to catch any coarse wolfram that may be present. If the percentage obtained by these concentrators should justify it, slimers for saving fine wolfram could be added. In order to ascertain whether the ore presents any difficulty to this form of treatment, I have had amalgamating and cyanide tests made at the Geological Survey laboratory. Mr. Bayly's report, appended hereto, shows a total extraction of 79 per cent. by amalgamation and cyanide, the consumption of the latter being high. As a preliminary test, however, it must be regarded as quite satisfactory; cyanide consumption would most likely be largely reduced when handling on the larger scale.

[13.5.14.]

AMALGAMATION AND CYANIDE TESTS.

The following tests were made by Mr. P. G. W. Bayly at the Geological Survey laboratory.

Report, Nos. 104–109.

Samples—Quartz., &c.
Locality—Lintons (Bass and Watson's Mine).
Sender—H. Herman, Director of Geological Survey.

Assays (previously reported).

Field No.	No.	Gold.	Silver.	Bismuth.	Tungstic Acid WO_3.
		dwt. gr.	dwt. gr.		
1	104	3 22	1 7	Strong trace ..	Nil
2	105	3 22	1 7	Strong trace ..	Nil
3	106	2 15	1 23	Slight trace ..	Nil
4	107	3 22	2 15	Strong trace ..	Trace
5	108	1 23	3 14	Trace	Trace
6	109 (Ironstone)	6 12	5 6	Trace	Nil (Sn. nil)

Treatment.

A bulk sample was made by taking equal portions of Nos. 104–108. This was crushed to 60 mesh.

Assay of bulk :—
- Gold .. .. 2 dwt. 15 gr.
- Bi. .. .. 0.13 per cent.
- WO_3 .. .. Trace

A. Amalgamation test—
- Extraction .. .. .. 1 dwt. 8 gr. = 50 per cent.

B. Cyanide test—
- Extraction .. .. .. 1 dwt. 8 gr. = 50 per cent.
- Cyanide consumed .. .. 0·31 lb. per ton ore.
- Lime required for acidity .. 2 lb. per ton of ore.
- Time .. .. 24 hours.

A further experiment was made in which the ore was first amalgamated and then the residues treated with cyanide—

	dwt.	gr.	
Extracted by amalgamation	0	22	= 35 per cent.
Extracted by cyanide (24 hours) ..	1	4	= 44 per cent.
Total extraction	2	2	= 79 per cent.

Cyanide consumed .. .. .. 3 lb. per ton of ore.
Lime required .. .. .. 2 lb. per ton of ore.

The ore contains soluble sulphate and chloride—principally sodium. Some of the bismuth in the ore is in a form soluble in water.

The experiments show that there should be no difficulty in direct treatment of this material by amalgamation and cyanide.

The total extraction obtained was about 80 per cent. of total gold present.

The consumption of cyanide was excessive (3 lb. per ton) : but this would be improved in practice, as an agitation test showed a much lower consumption.

[12.5.14.]

CHINA CLAY AT LINTONS.

By W. Baragwanath, Senior Field Geologist.

A deposit of china clay is situated in allotment 4, parish of Argyle, on the Lintons-Skipton-road, about 1 mile and a quarter south-east of the Junction Hotel.

The formation consists of decomposed, highly felspathic, binary granite, an almost entire absence of mica being noticeable. Some of the material was taken from a shallow quarry, and placed as blinding on the adjacent roads. Where exposed to atmospheric agencies the kaolin has in places acquired a glaze with considerable hardness, but a shallow pit sunk by Mr. O'Meara, prior to my visit, shows the material to be much softer in the undried portion.

A cursory examination shows the formation to be very extensive, probably underlying several square miles of country. In the quarry many veins of nearly pure kaolin intersect the decomposed ground mass of the rock. The colour of the material is snowy white, and very little iron staining is visible. Puddling will be necessary, and the quartz, which forms one quarter of the whole, will require washing off. The general appearance of the material suggests that the deposit may prove of value.

A sample was tested at the Geological Survey laboratory by Mr. P. G. W. Bayly, who reports as follows:—"The sample (No. 65) is decomposed granite with kaolinized felspar. It contained clean quartz grit, which was easily separated by washing from the fine white clay portion. The proportions were:—

	Percentage.
Quartz grit	56
China clay	44

The quartz is white to gray in colour. Test pieces were made up of the material after crushing fine, including the quartz (A) and also of the fine white washed clay free from grit (B). The pieces were dried and treated at various temperatures with the following results:—

	(A)	(B)
Test O, air-dried—		
Colour	White	White
Shrinkage	4 per cent.	6 per cent
Test A, muffle heat, 1,100° *Cent.*—		
Colour	White	White
Shrinkage	4 per cent.	11 per cent.
	Soft biscuit	Harder biscuit
Test B, wind furnace, 1,340° *Cent. (after muffle, twice burned)*—		
Colour	Dull white	White, slight iron stain (superficial)
Shrinkage	11 per cent.	25 per cent.
	Moderately hard	Dense, hard
Test C, wind furnace, 1,340° *Cent. (once burned)*—		
Colour	Dull white	White, slight iron stain (superficial)
Shrinkage	11 per cent. ..	25 per cent.
	Moderately hard ..	Dense, hard

The clay is semi-plastic. The tests indicate that the material, if properly treated and existing in sufficient quantity, would be of value for the manufacture of pottery and china ware. The washed material represents very pure china clay, with very little iron. The shrinkage is high.

Further tests have been made by compounding the washed material with felspar; the tiles in this case burned well and evenly. Experiments made by applying hard and soft glazes, showed that the clay takes the glaze well, and is suitable for the manufacture of tiles and other glazed ware. No analyses were made."

[8.2.13.]

SOME MINES AT SCARSDALE.

By W. Baragwanath, Senior Field Geologist.

The Scarsdale Mine, Scarsdale.

The Scarsdale mine is situated on the western side of the Ballarat-Scarsdale railway line, within a quarter of a mile of the railway station.

While prospecting in 1912, Messrs. Knight and Williamson located auriferous quartz within a few inches of the grass roots. The subsequent workings of the prospectors revealed a small gold-bearing spur, associated with a large mass of leaders which was of low grade, and this was followed to a depth of 55 ft. on its southerly pitch. Later a lease was secured, and the Scarsdale Company floated. In 1913 the sinking of a main shaft was decided on, the deepest shaft of the prospectors then being 70 ft., at which depth no payable stone had been located. The main shaft was sunk to a depth of 200 ft., proving one small auriferous vein at 70 ft. At 170 ft. quartz leaders dipping east were found, which continued to near the plat at the 200 ft. level before passing out.

200 *ft. Level.*—In the east cross-cut at the 200 ft. level a gold-bearing vein dipping east was cut at 22 ft. from the shaft. From this vein a crushing of 50 tons averaged 12 dwt. to the ton. Shaft sinking was then continued, and a cross-cut was opened out east at 275 ft., to prove the downward continuation of the flat vein. At 60 ft. from the shaft a lode formation 8 ft. in width was met, carrying payable values. Driving north and south on this lode proved a length of 140 ft., averaging 8 ft. in width and assaying 9 dwt. to the ton. A bulk crushing from this lode yielded 8½ dwt. to the ton. The lode formation had a dip to the west averaging 70° to 85°, and north from the cross-cut it continued payable up to a cross-course at 45 ft. This cross-course heaves the lode 25 ft. to the west, but where again picked up the quartz was poor. Beyond the cross-course a full face of quartz was followed for 100 ft. in the drive. At 10 ft. from the cross-course a rise was put up meeting a roll in the lode at 15 ft., above which payable stone was risen on for 60 ft. A fault (the slide) was cut in the floor of this level where the lode was picked up north of the cross-course; this fault pitches to the south and rises to the north, passing over the back of the drive at 50 ft. from the cross-course. A flat vein or spur of low grade, dipping east into the lode, was located over the fault.

275 *ft. Level.*—In the south drive at this level the lode was 7 ft. in width for a length of 90 ft., and it then broke up into spurs with no sign of a wall. Stoping was carried on for a length of 140 ft., 90 ft. being to the south of the cross-cut and 50 ft. to the north. The stopes at the south face are 20 ft. over the level, with a maximum height of 40 ft. over the cross-cut; the lode varies from 3 ft. to 8 ft. in width, and consists of a fractured body of quartz with secondary pyrites on the joint surfaces. At 40 ft. south of the cross-cut a winze was sunk 35 ft. to the fault (slide). A lode formation ranging from 8 ft. to 10 ft. in width with a slight dip to the west was proved, and an intermediate level was opened out north and south at 30 ft. below the main drive, exposing at 25 ft. from the winze a lode 10 ft. wide in both faces, and valued at 4 dwts. to the ton. This lode formation ends abruptly on the fault.

At a depth of 375 ft. another level was opened. In the plat a large low-grade lode formation with a well defined wall dipping to the west at 65° and carrying 6 ft. of solid quartz and several feet of spurs, was located. In the east cross-cut at 40 ft. from the shaft a body of quartz dipping east at 45° was met, differing from the lode in the level above, which had a westerly dip of 80° to 85°. In the south drive on this formation, quartz of fair value was followed for 60 ft., and the east dipping formation was driven on south to 90 ft., where a west dipping fault pitching to the south cut off the stone. This fault was followed to 165 ft. from the main cross-cut, where it passed underfoot, carrying in its drag a little quartz. Two cross-cuts westerly were put in from the south drive, No. 1 at 70 ft. and No. 2 at 160 ft. respectively. In the No. 1 south cross-cut the east dipping lode attained a height of 7 ft. at 4 ft. west of the main drive before being cut off by the fault, which dips to the west at 40° and pitches south at 25°. Over this fault, at 25 ft. west, a crumpled anticline occurs. On this fold black slate and quartz spurs exist, and in the west face at 40 ft. from the main drive there is a west dipping formation consisting of laminated quartz, the upper portion of which is cut off by an east dipping fault. The spurs and bodies of quartz in this cross-cut carry a little gold, but are not payable.

In the No. 2 south cross-cut the main fault shows at 4 ft. west of the main level, and below this there is a lode formation of fair quality. Owing to the influence of the fault, it is not possible to say if this is the continuation of the east dipping formation as followed to 90 ft. in the south drive, or whether, taking the fault as a hanging wall, it may be a west dipping formation. Beyond the fault the strata dip west at 45°, and at 15 ft. west of the main drive, a small fault was cut dipping east.

At 145 ft. south of the cross-cut a rise was put up on the fault which dipped west at 75°. This rise followed the fault drag, being in poor stone up to 40 ft., where the main fault (slide) was cut, above which 25 ft. of fair grade stone was risen on. About 30 ft. north of the rise an incline cross-cut met the main fault at 37 ft. At 45 ft. south of the main cross-cut a rise was put up on the east dipping lode; which was followed for 12 ft. to where the west dipping fault cut off the stone. The west dipping fault was followed for 19 ft. to a point below the winze sunk from 275 ft level, and a little quartz was met with in the drag. No lode being located, a vertical rise of 30 ft. was put up in blank country to connect with the intermediate level.

In the winze, 60 ft. south of the main cross-cut, the footwall of the lode was at the west side of the sill, but at a depth of 20 ft. it was 14 ft. to the east. At this latter point the stone was disturbed and the quality was not as good as in the main level.

North of the cross-cut the east dipping formation was followed for 35 ft., the stone becoming smaller as driven on. The strata containing this stone dip to the east at 75°. At 35 ft. north of the cross-cut a laminated lode 6 in. to 8 in. wide and striking 20° north of west was located in the cross-course. This stone was poor, and the lode was very small when picked up on the north side of the cross-course. A cross-cut at this point is now being driven, and at 70 ft. from the north drive is still in clean strata dipping east 75°. At the 475 ft., the deepest level, a cross-cut has been put in east for 106 ft. A few quartz spurs occurred at 20 ft. and 60 ft. from the shaft, but they were of no value. The strata dip east at 75°. Two small cross-courses show at this level, one in the plat being identical with that exposed at 5 ft. south of the cross-cut at the 375-ft. level. No driving has yet been done at this level.

To summarize the position of the mine. Gold-bearing quartz has been located in four distinct formations—

(*a*) In the original prospectors' shallow workings.

(*b*) In the spur or flat vein at 25 ft. east of the shaft at the 200 ft. level.

(*c*) In the large, nearly-vertical lode 60 ft. east of the shaft at the 275 ft. level, and which carried gold for 140 ft. in length and over 70 ft. in height.

(*d*) In the east dipping formation 40 ft. east of the shaft at the 375 ft. level.

No connexions between these formations can be established. The ore bodies were irregular and not continuous, and their values are likewise irregular and of low value. The lodes all occur in east dipping strata, the shaft having been sunk apparently in an anticlinal fold. What appears to be a more permanent lode formation was cut in the east cross-cut at the 200-ft. level at 84 ft. from the shaft, and also in a mullock rise from the stopes below, but it was not located in the other cross-cuts from the shaft. This formation consists of a graphitic track with 8 in. of crushed mineralised quartz and strata. The faults (slides), while apparently cutting off the lodes, may yet be found not to have such an effect, as the lode bodies may be proved to end on them. The occurrence of quartz in the northern cross-course at the 375 ft. level is known in the vicinity, being found in the Jubilee, East Jubilee, and Birthday New Find Mines, but in these gold values were obtained from the stone.

Future operations must be confined to development and prospecting. The block of quartz proved above the 375 ft. level south can be worked above the fault, while the continuation of the south level should prove the fault to reach closer to that level, which would result in the lode formation, if it continues, being the more accessible. A winze should be sunk in the south drive near the face of the 375-ft. level, to prove the lode now exposed under the west dipping fault. This work should be completed before prospecting is carried out at the 475 ft. level, as any prospecting at that level would be purely experimental. The extension east of the cross-cut may be the most likely source of development.

The mine is equipped with a suitable winding and crushing plant, comprising three Cornish boilers, one 16 in. cylinder winding engine, and sinking winch. A 22 in. cylinder engine for the battery, 20 head of stampers, and 2 Wilfley tables complete with sand pumps, etc.

To date about 3,600 tons have been crushed for a yield of 680 oz., exclusive of 750 tons treated elsewhere, which averaged 5 dwt. to the ton, prior to the erection of the company's battery.

[2.8.15.]

Jubilee Mine, Scarsdale.

On going through the manager's plans of the Jubilee Mine, Scarsdale, a cheap scheme of working this mine suggests itself in the utilization of the plant, boilers, battery, etc., on the ground, and the sinking of an incline shaft starting from a point about 100 ft. north of the present shaft, connecting at the 1,966 ft. level, about 30 ft. north of the mine. Such an incline would be about 68° 41′ from the horizontal. The advantages accruing from such a scheme would be:—

(*a*) Short cross-cuts of uniform length—about 30 ft.

(*b*) Utilization of existing machinery (the winding engine would require new alignment).

(*c*) A connexion for an air-way to the present shaft could be secured at intervals by short drives.

(*d*) The proposed shaft would be in the footwall country and away from the influence of the break, which has caused trouble in the present shaft.

(*e*) Cheaper handling of ore with skips and bins.

The disadvantages would be an additional length of haulage—about 7 ft. in 100 ft., and the consequent wear and tear, which, however, would be comparatively small at such an angle.

Taking into consideration the continuity of the shoot, together with the general observed inclination as a guide to its position, such a shaft should enable work to be carried to any desired depth.

[13.3.13.]

SMEATON RESERVE UNITED MINE.

By W. Baragwanath, Senior Field Geologist.

The Smeaton Reserve United Company was formed in 1882, and secured a lease of private property in the township of Smeaton and its vicinity, the greater portion being situated on the eastern side of the main Ballarat to Castlemaine road. Shaft sinking was commenced on the western bank of Birch's Creek, at the rear of the Smeaton show-

grounds. The mine was equipped to cope with a heavy body of water, and operations proceeded smoothly up to April, 1884, but then at a depth of 212 ft. a flow of water was struck which proved to be more than the capacity of the pumps (one 16 in. lift being out of working order), and in a few hours the water rose 60 ft. in the shaft. Work at the mine ceased until June, 1886, when the two 16 in. draw-lifts were set to work on seven 7-ft. strokes to the minute. At this date the water level was 58 ft. from the surface, but was speedily lowered to 125 ft., where the bulk of the water was met with. The pumps were then increased to seven and a half strokes per minute, and by the 15th September, the water was out of the shaft, and sinking was resumed. A few days later heavy water was again struck, and an additional lift of 15 in. diameter had to be installed. The three pumps were worked on five 6-ft. strokes to the minute, and a quantity of from 40,000 to 60,000 gallons of water per hour was raised. At 220 ft. from the surface hard rock was passed through, followed by 3 ft. of honeycombed and 3 ft. of basaltic scoria before reaching the second basalt rock. At 272 ft. the second rock was passed through, and below this 2 ft. of pure black clay, followed by a few feet of sandy clay of a grey colour. From 277 ft. to 313 ft. a yellow clay was passed through, below which there was 7 ft. of gravelly wash with heavy waterworn quartz boulders, in which gold was found, though

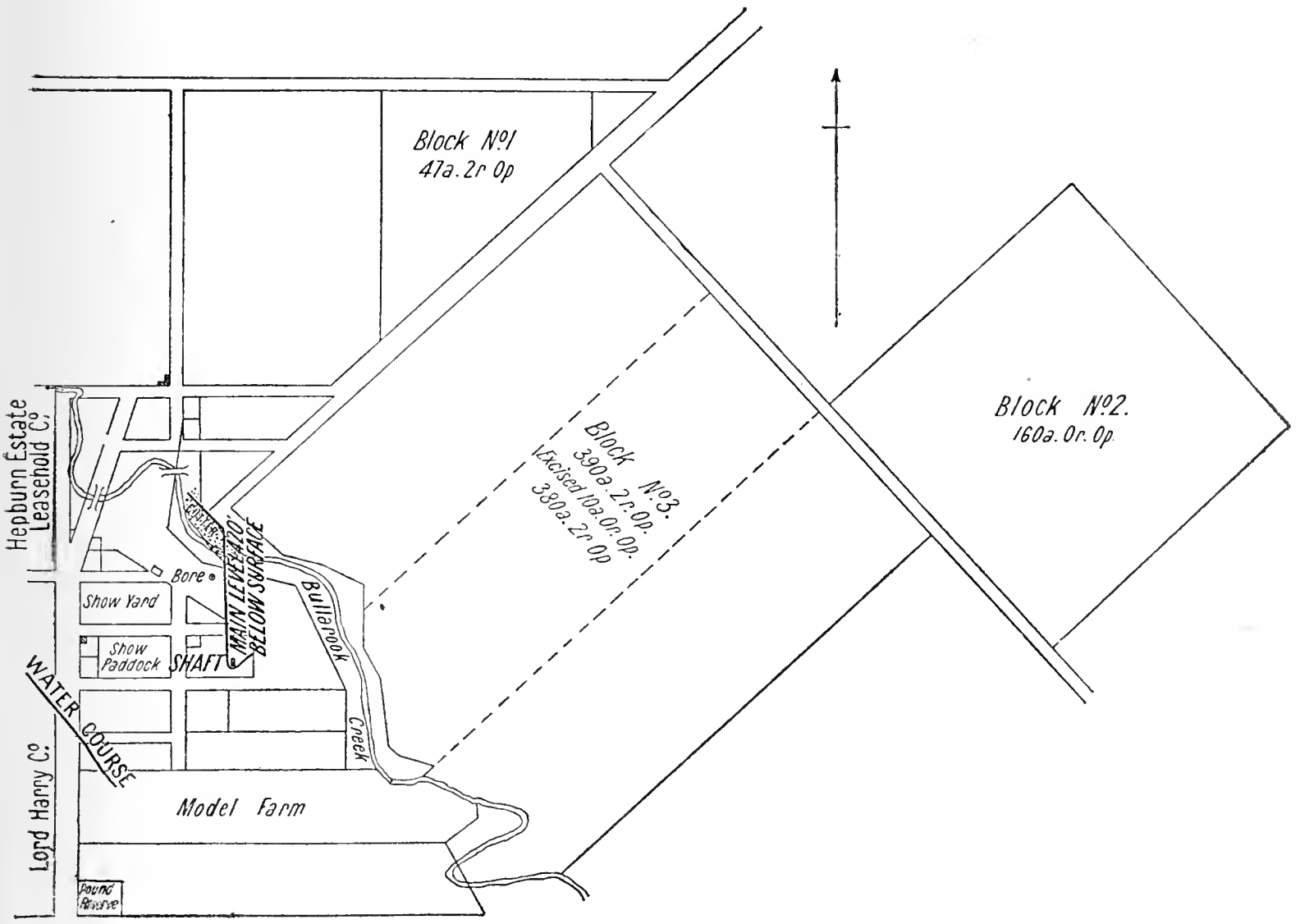


FIG. 41.—Plan of Smeaton Reserve Mine.

(Scale—32 chains to 1 inch.)

not payable. At 320 ft. the shaft was bottomed, but sinking was continued to 430 ft. At 420 ft. a level was driven and a prospecting reef drive was put in to the north-east for 290 ft., also a main north drive to

1,130 ft. from the shaft; from which point the drive was turned north-westerly and continued for a further 405 ft. Before boring into the wash the water was pumped by six 5 ft. strokes per minute on a 19 in. plunger. Several bores were put up from the north drive with the following results:—

Bore.	Distance from Shaft.	Wash Cut at—
	Feet.	Feet.
1	475	72
2	602	66
3	716	49
4	768	50
5	820	46
6	868	43
7	898	40

Nos. 1 to 5 proved wash with colours of gold.
Nos. 6 and 7 proved heavy wash with a sample of gold.

At 847 ft. from the shaft a water rise was put up from a cross-cut 23 ft. west of the main level. At 882 ft. north the No. 1 rise was put up and opened out to the east and west in a large body of poor wash. At 1,120 ft. the No. 2 rise was put up to the wash and opened out and driven to the east for 30 ft. with improved prospects, while to the west the wash was poor. By October, 1889, an area of wash 600 ft. by 400 ft. was opened up, but it proved to be poor and on an uneven bottom. One hundred and eighty nine machines were washed for a yield of 712 oz. 15 dwt. of gold, averaging 3 oz. 15 dwt. to the machine. At 180 ft. along the north-west drive past the No. 2 rise, the No. 3 rise was put up, and from the top of it a drive westerly cut at 200 ft. the run of wash proved in the No. 2 or middle rise. From the middle rise a drive to the east met the rising ground at 200 ft., this drive was continued in a north-easterly direction under Anderson's mill for a total length of 782 ft., and the following bores were put up:—

Bore.	Distance from Rise.	Wash Cut at—
	Feet.	Feet.
2	494	30
3	544	32
4	604	35
5	718	37
6	788	39

No. 4 showed no gold. Nos. 5 and 6 cut cemented wash.

From this drive a rise (New Eastern rise) was put up and wash drives started. Only poor wash was located, and a series of terraces coming in, operations ceased in March, 1890.

In the main level north-west drive No. 4 rise was put up at 230 ft. from the No. 3 rise, and a drive was then opened out 83 ft. east in a strong body of poor wash.

The result of these workings tend to prove a well-defined lead, 400 ft. in width, and resting transversely on an even bottom, trending north-westerly between 800 ft. and 1,200 ft. north of the shaft, and under the present course of Birch's Creek. The deepest point 380 ft. below the sill of the shaft, makes the bedrock level here 1,028 ft. above sea-level.

[17.9.17.]

BROWN AND BLACK COAL NEAR WINCHELSEA.

By H. Herman, M.M.E., etc., Director, Geological Survey.

Brown coal occurs along the western branch of Wormbete Creek, about 7 miles south of Winchelsea, in blocks 72B, 73B, and 74C, Parish of Yan Yan Gurt, County Polwarth. These blocks are shown on the parish plan in the name of C. Strickland, but at present are held by H. E. Armistead.

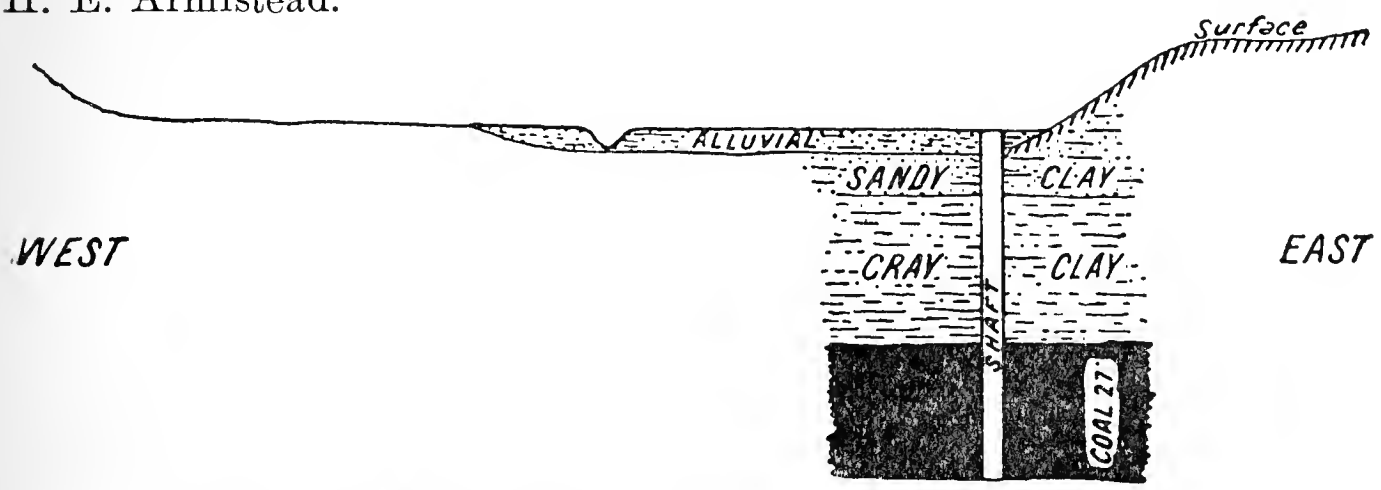


FIG. 42.—Sketch Section, showing 27 feet of Coal.
(Scales—Hor., 120 feet to 1 inch; vert., 60 feet to 1 inch.)

A seam of brown coal, 27 ft. thick at the only point where it has been completely passed through, lies close to the surface, interbedded nearly horizontally between various clays and sandy clays, as shown in Figs. 42 and 43, which illustrate the information revealed by two shafts in the creek flat about a quarter of a mile apart, Fig. 42 showing the shaft up-stream from that in Fig. 43.

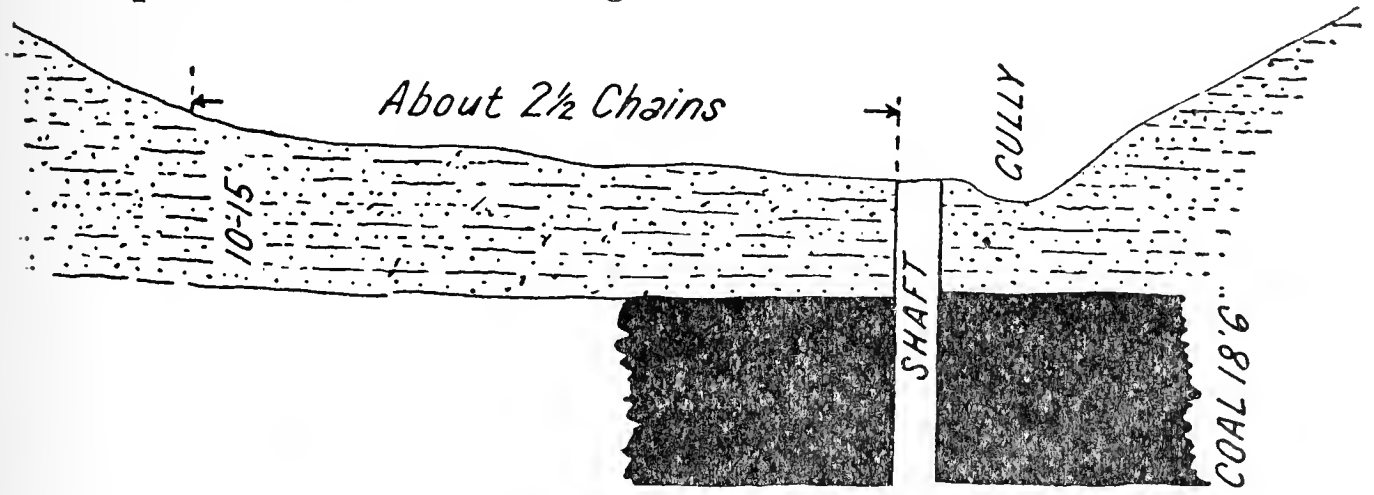


FIG. 43.—Sketch Section, showing 18 feet of Coal.
(Scales—Hor., 60 feet to 1 inch; vert., 30 feet to 1 inch.)

About 10 chains northerly along the creek from the shaft in Fig. 43, a third shaft (filled with water at my visit) is stated to be 30 ft. deep, and in brown coal from 8 ft. down, showing a thickness of at least 22 ft.

Analytical tests at the Geological Survey laboratory show the coal to be of good quality. Details of these tests are given in the report hereunder. An appreciable proportion of potash salts occurs in the ash.

The brown coal seam is quite likely extensive, and may be underlain by other seams. Its extent could be ascertained, probably at a low cost, by boring. Its geographical position and good quality should give it a place in the category of brown coal deposits of the State that may be economically important at a future date.

Similar coal has been found at Dean's Marsh, about 9 miles to the south south-east; the two occurrences may belong to the same geological series.

After inspecting the brown coal workings I was taken to see a black coal seam, the position of which was described to me as in the Parish of Wensleydale, about half-a-mile northerly from block 8 (J. Armistead), Parish of Boonah.

The seam is exposed in the banks and bed of a gully running north-easterly. Where first seen it is about 3 in. thick, in a shale band, succeeded both above and below by typical Jurassic alternating standstones and rubbly shales. The dip is about 15° E. to east-north-east. About a quarter of a mile lower down the gully the seam is 2 in. or 3 in. thick, dipping (in the bed of the creek) about 10° easterly. This seam is manifestly of no economic value.

[21.12.14.]

LABORATORY REPORT NOS. 375, 376, 377 (1914).

Two samples Nos. 375 and 376 were in bulk about 40 lb. each, and consisted of typical earthy brown coal.

No. 377 consists of vegetable resin derived from the brown coal.

The large samples were broken down and sampled for analysis. Distillation tests were then carried on in the experimental plant devised for the purpose, and the resulting tar was distilled.

ANALYSIS.

—	No. 375.		No. 376.	
	Raw Coal.	Calculated free from water.	Raw Coal.	Calculated free from H_2O.
H_2O	40·06	...	33·91	...
Vol. hydrocarb.	26·65	44·46	32·70	49·48
Fixed carbon ...	30·73	51·27	30·52	46·18
Ash	2·56	4·27	2·87	4·34
Total ...	100·00%	100·00%	100·00%	100·00%
Nitrogen (N) ...	0·39%	0·655%	0·402%	0·609%

Partial ultimate analysis :—

Carbon, 68.56%.
Hydrogen, 4.82%.
Nitrogen, 0.655%.

The coal is non-caking, and burns with a short flame, with little smoke, the ash is reddish-grey in colour, and infusible.

The moisture content is low, the samples probably being partly air dried through exposure.

DISTILLATION TESTS.

—	No. 375.		No. 376.	
	Raw Coal. (H_2O 40%)	Moisture free.	Raw Coal. (H_2O 34.0%)	Moisture free.
1. Ammonium Sulphate—	per ton.	per ton.	per ton.	per ton.
Recovered from Liquor ...	5·8 lb.	9·7 lb.	8·3 lb.	12·6 lb.
Recovered from Tar ...	·73 lb.	1·2 lb.	·55 lb.	·8 lb.
Total	6·53 lb.	10·9 lb.	8·85 lb.	13·4 lb.
2. Tar	67·4 lb.	112·3 lb.	65·7 lb.	99·5 lb.
3. Gas (cubic feet)	7,467	12,445	9,251	14,002
4. Carbonaceous Residue ...	747 lb.	1,245 lb.	738 lb.	1,118 lb.
5. Salts recoverable from ash (Potash &c.)	12·7 lb. =381 lb. per ton ash.	21·2 lb.		

NOTES ON THE BACCHUS MARSH DISTRICT.

By W. H. Ferguson, Assistant Field Geologist.

To settle the age of the Palæozoic rocks in the Werribee Gorge, a search was made there for fossils, and a band of slate containing graptolites was found opposite the shelter shed for tourists. These graptolites have a striking resemblance to those gathered by me in the lower part of Sutherland's Creek, south of the Hanover fault, and about 3 miles south of Steiglitz; they also resemble a collection from the Geelong Waterworks Reserve, about 6 miles north-east of Steiglitz. As the rocks of the gorge are some miles west of the strike of those at Steiglitz, it will be interesting to compare the identifications from each place; probably the Castlemaine rocks to the west of Daylesford are more than 10 miles wide and connect with those of Steiglitz and the Werribee Gorge. Within that area are the two goldfields of Blakeville and Blackwood, where I have found Bendigonian fossils. It is probable that the Blakeville and Blackwood rocks pitch south and pass under the gorge; at one place on the Werribee the pitch is south at a low angle. The folding of the rocks at the gorge resembles that at Steiglitz; the anticlines and synclines occur at short intervals.

In Goodman's Creek, about 5 miles north of Bacchus Marsh, slate pebbles, containing graptolites, which appear in the Castlemaine series, were found at the foot of a high cliff of glacial conglomerate. I do not think, however, that these pebbles were derived from the cliff, as the slate pebbles from the glacial conglomerate are different. It would probably be easy to locate up the creek the fossiliferous bed from which they came.

An outcrop of Ordovician rocks in the bed of the Lerderderg River, under Darley bridge, is probably the nearest Ordovician outcrop to Bacchus Marsh. Another outcrop is seen in or near allotment No. 42, section XVIII., parish of Merrimu. It stretches across the Lerderderg River about half-a-mile east of the Darley bridge, and it is not shown on the geological sketch map of Victoria. It consists of sandy shales and sandstones intersected by many quartz veins.

There is a fine romantic gorge in the Lerderderg River, about 5 miles from Bacchus Marsh. The road to it requires cutting down in one place and two gully crossings improved elsewhere to make it available for motor traffic. In the upper portion of the gorge, gravels resting on Ordovician slates and sandstones have been worked for gold.

Permo-carboniferous Rocks (*Bacchus Marsh Sandstones*), *&c.*—One of the objects of my visit was to make a collection of sandstones, especially those useful for building purposes, specimens of glacial conglomerate, sandy shales and clay shales of the Permo-carboniferous or Bacchus Marsh series. Some of these were collected in the Werribee Gorge, but the majority came from the vicinity of Bald Hill. Intrusive into the glacial conglomerate on the bank opposite Mr. J. W. Baird's pre-emptive section are two basaltic dykes—one black and decomposed

about 4 ft. thick, which has metamorphosed the surrounding rock, the other about 12 ft. thick, decomposed to a clay. Siliceous sandstone veins occur in the glacial conglomerate.

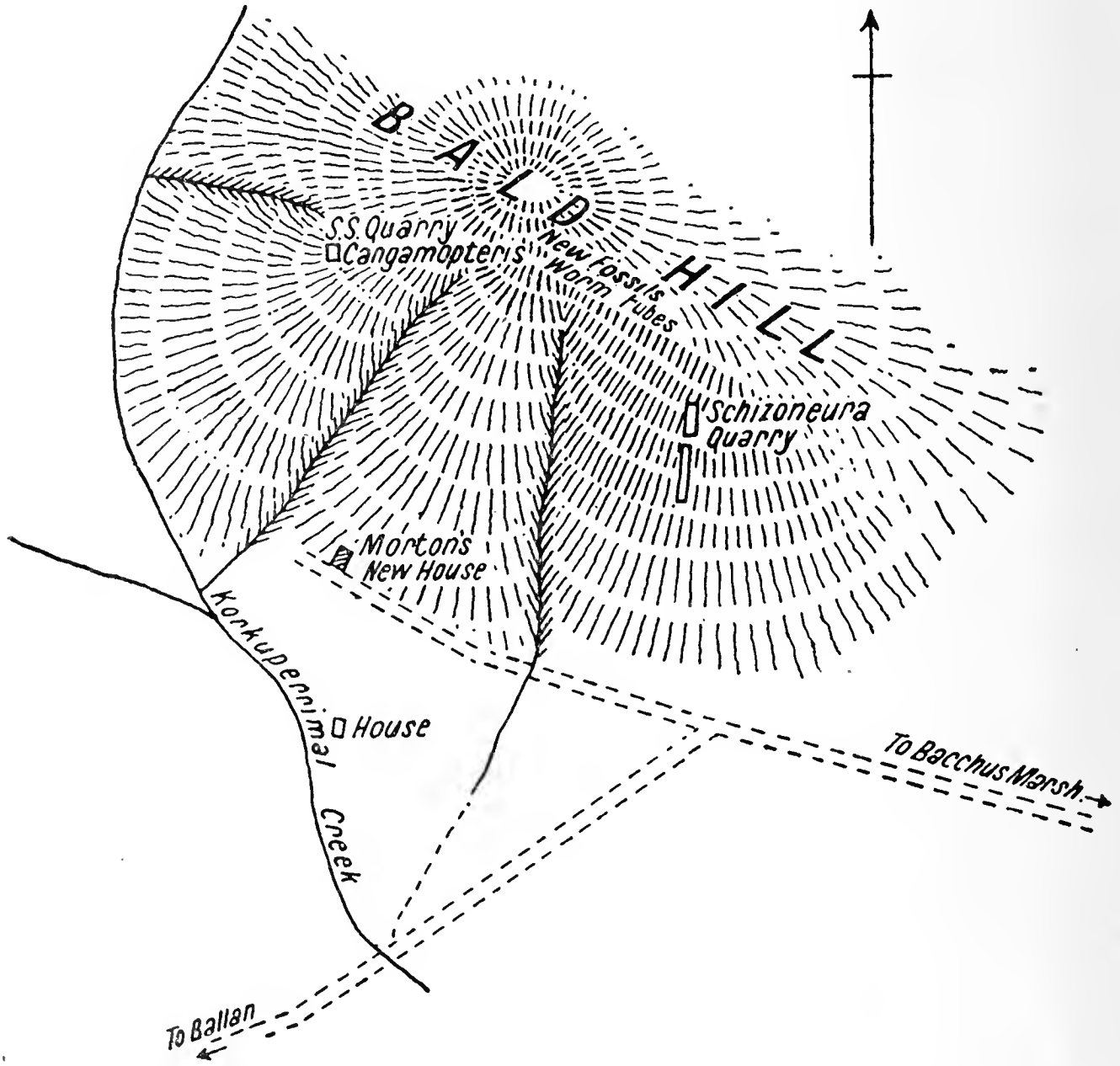


FIG. 44.—Plan of Bald Hill, Parish of Korkuperrimul.
(Scale—40 chains to 1 inch.)

About a quarter of a mile above this place a quarry has been opened in a workable face of sandstone underlying glacial conglomerate. The stone is slightly soft, but huge blocks could be obtained. Some of this stone was used at Parliament House, Melbourne, and, although Mr. Baird's house has been built for fifty years, stone placed in position then still retains the sharpness of its edges. It should be suitable for use where the crushing strain is not too severe, and if selected and used with judgment. Care should be exercised in placing the bedding plane of the stone horizontally.

Bald Hill.—The vicinity of Bald Hill is a very interesting portion of the Bacchus Marsh district (Fig. 44). The Permo-carboniferous rocks outcrop frequently on the hill slopes from allotment 8, sec. XVI., parish of Korkuperrimul, to the Korkuperrimul Creek, and in the sandstones several quarries have been opened to supply a local building stone; it does not, however, appear to have been much used of late years. A considerable amount of freestone—white, yellow, pink, and brown, has been taken from a quarry in allotment 8. The sandstones in this quarry are associated with the glacial conglomerate, and contain the fern Gangamopteris. In a quarry, about 40 chains further east, I found some fossil plants ascribed by McCoy to Schizoneura, and near the hill-top

in ironstone layers, some very small fossils, which Mr. F. Chapman considers of the nature of worm tubes; he also recognised two umbones of a small shell. The relation of the thick sandstone bed to the Schizoneura shales and the new fossils in the ironstones has not been established; the last-named appears to lie stratigraphically above the Gangamopteris layers, and are above the highest layers of glacial conglomerate noted on the hillside. The strata below the ironstone fossiliferous beds are thin bedded and dip generally at a low angle into the hill. A band of conglomerate in one place shows a certain amount of movement, and is ultimately lost on a north-westerly pitch. There are many thin-bedded layers of sandstone, sandy shale, and clay shale; the last-named in places forming a distinct layer, in other places passing into a succession of scone-like nodules. This rock contains markings resembling worm burrows filled with clay, but there is an absence of the shelly material seen in the rocks above. Thin beds and rapid alternation of sediments suggest deposition under shallow water conditions, an inference supported by the existence of worm burrows, and one fine sandy layer, which is rill-marked. The worm tubes and burrows were noted for over a quarter of a mile easterly from the site where they were collected; they appear to constitute a series having a thickness of upwards of 20 feet with a fairly persistent strike.

A dyke now decomposed to a brown clay has been intruded into the glacial conglomerate in the lower part of the Lederderg Gorge.

On the eastern branch of the Korkuperrimul Creek there is an old soil, firm and consolidated, overlying the Bacchus Marsh sandstone and covered with a flow of basalt from the older series. It is composed of water-worn pebbles, angular fragments of sandstone, shale, and pieces of charcoal.

A series of white and exceedingly fine sands intercolated with gravels and nodules of magnesite outcrops from under the newer volcanic basalt on the east side of the Lerderderg River, on Gorman's farm, allot. A, sec. XVII., parish of Merrimu. The fine sand contains a very small amount of cementing material, probably alumina, and is blended with magnesite.

About half-a-mile further north there is another outcrop of similar fine white sand, in places indurated by the overlying basalt. Sand of this texture and purity should be suitable for the manufacture of superior glass.

Samples of sandrock and fireclay were obtained from the first railway cutting on the Melbourne side of the Bacchus Marsh railway station. I was informed that fireclay linings for locomotives are manufactured from this clay.

The Darley Firebrick Co. Ppty. Ltd., whose works are situated about a mile from Bacchus Marsh, obtain their clay, gravel, &c., from a quarry at their works. The clay is mixed with gravel and previously burnt ground fireclay material. All kinds of retorts and firebricks are made from patterns for customers in this and other States. Some retorts made for the Metropolitan Gas Co. are 10 ft. high. Samples of the clay and products were obtained for the Geological Survey museum.

A white, tough, adhesive clay, resembling ball clay, was obtained from a decomposed dyke which intersects the Ordovician rock bands at the Darley bridge, where it crosses the Lerderderg River, 2 miles from

Bacchus Marsh. The Geological Survey laboratory made up a sample (Assay No. 499) into test pieces, and burned them, with the following results:—

—	Test Piece.	Conditions after Test.		
		Shrinkage per Cent.	Colour.	Hardness, &c.
O	Air dried	4	White	Firm hard tile
A	1100° C	8	White	Cracked
B & C	1340° C	22	Blue	Vitrified

The laboratory summarizes this test as follows:—"The shrinkage is high and the amount of fluxing material present causes vitrification at a high temperature. The clay is of no value by itself, but if existing in large quantity could be used with other materials as a clay body."

The dyke, however, is only about a foot wide, and unless larger dykes of similar material exist in the vicinity its value would be minimized.

Samples of magnesian limestone (dolomite) were collected at the quarries of Messrs. Alkemade and Burnip, at Coimadai. This limestone, though high in magnesia, makes a hard and durable hydraulic mortar. The lime is sold according to the following standard:—

	per cent.
Lime carbonate	55.00
Magnesian carbonate	41.00
Silica and alumina	2.05
Iron oxide	1.90
Water, &c.	.05

Mr. Alkemade presented a few fossil bones to the Department, also a piece of ostracodal limestone. Samples of soils formed from the decomposition of Lower Ordovician strata, Bacchus Marsh sandstone, glacial conglomerate, and soils were collected.

[30.8.13.]

THE GEOLOGY OF THE PARISHES OF PARWAN AND MOORADORANOOK.

By W. H. Ferguson, Assistant Field Geologist.

General.

This report deals with a geological and topographical survey of an area of about 20 square miles in the parishes of Parwan and Mooradoranook, county of Grant, Bacchus Marsh district. The area is situated south of the Werribee River, and is crossed by the Melbourne to Bacchus Marsh railway. Parwan, the nearest railway station, is just outside the western boundary. It is 29 miles from Melbourne, and 464 ft. above sea-level. The country consists of a basaltic tableland, much of which is from 400 ft. to 500 ft. above sea-level.

The principal natural feature is the Werribee River, which bounds the survey on the north and east.

The tableland has been built up of layers of sands, gravels, &c., interbedded with flows of basalt, both of Tertiary age; it extends beyond

the limits of the survey to the north-east, also to the south-east towards the township of Werribee, where the height above sea-level is much lower.

The Werribee River has cut its bed through these strata to a depth of 200 ft. in places.

The soil of the area is fairly fertile, and some is very rich. Of late years the large holdings have been cut up into farms, and a considerable extent of the country is under cultivation, or is being prepared for the plough. In places the basalt outcrops at the surface, and renders the clearing of land expensive, but the removal of the timber—principally box and redgum—is not costly.

Basalt Flows and Points of Eruption.

In the area surveyed are a number of flows of basalt, which may be seen in the sections along the Werribee River, from north of the railway station of Parwan to the limit of the survey below Exford bridge. In the section which was made on the river bank, about 1 mile north-easterly from Parwan railway station (Fig. 45), three flows of basalt are shown, with the possibility of another one concealed by talus.

It is possible that in places there are four or more flows, as for example, in the long road-cutting on the south-west side of the Werribee River leading to the Exford bridge. Here there are the junctions between flows of lava, indicated by cellular and ropy structure, and by the top of the underflow resembling burnt clay. It is possible that such a tight contact may open in another place, and the flows of basalt be separated by a layer of sediment.

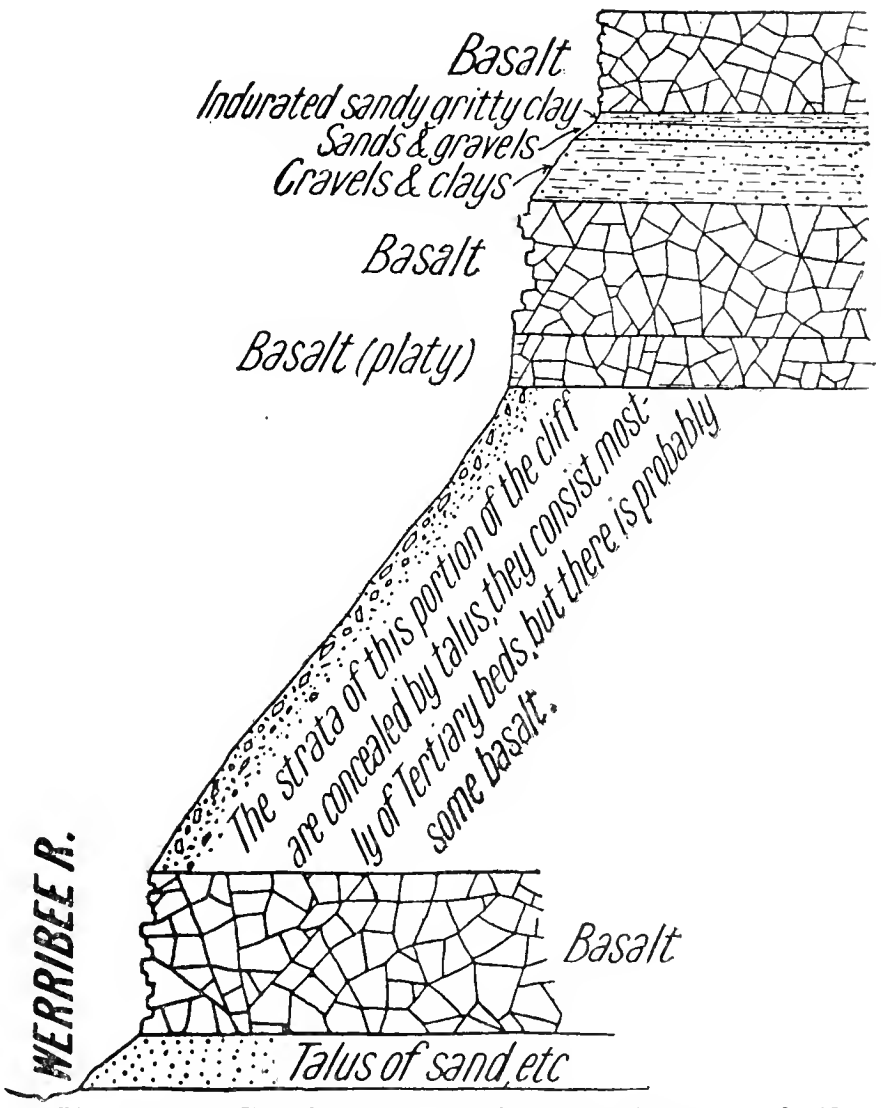


Fig. 45.—Section one mile north-east of the Parwan Station. Not to scale.

Over most of the area surveyed the basalt was medium grained to more or less cellular, but on allotment No. 17c, parish of Mooradoranook, there is some tachylyte. In this allotment a small gully enters the Werribee, and on its south bank there is a section exposed of Tertiary sands and gravels, overlain by a flow of basalt, which is normal in character, except for about 3 or 4 inches from where it rests on a layer of gravel, where it is a dense black, somewhat brittle tachylyte, but differs in appearance from the blue tachylyte of Meredith.

Within the area surveyed there are one or more minor points of eruption. What appears to be a perfect crater is the main surface feature on allotments Nos. 10 and 11 of section VIII., parish of

Parwan. It is 3 miles south of the Parwan Railway Station. The hollow is beautifully regular, and the rocks around it are basalt, scoria, and some tuff, which includes fragments of what are apparently Ordovician rocks, also waterworn quartz pebbles. One small piece of included rock was of great interest, as it contained one valve of a bivalve shell, with the hinge line teeth well preserved. This shell appears to be of marine origin, and may be of Tertiary age, and, if this is the case, it indicates that there were beds of Tertiary marine strata underlying the volcanic rocks. This is not surprising, for at Mt. Mary, 5 miles to the south-east, "blocks of white and yellow argillaceous sandstone containing Miocene Tertiary fossils are embedded in the scoriaceous lava of Mt. Mary," according to the note on the geological map. (Quarter sheet, 8 S.W.)

None of the basaltic flows were traced to their point of origin. Some may have issued from Mt. Mary, or there may have been a series of fissure vents along a line from Mt. Mary to the small crater just described; or, as the land is higher in that direction, some may have come from the north-west.

Sands, Gravels, and Clay Inter-stratified with the Basalt.

The Tertiary rocks inter-stratified with the lava flows exposed in the cliffs along the Werribee River consist of sands, gravels, earthy grits, clays, and some sandy ferruginous rocks. Some of the sands are fine grained, but not pure white in colour. A band of sandy clay is lignitiferous, and there is a layer of black clay in part earthy, and in part unctuous. Some of the sandy clays are very saline and effloresce, the mineral tasting like common salt. The layers of basalt and Tertiary sediments are arranged more or less horizontally, and in places the surface of the ground slopes very gradually to the river. If a layer of sand or gravel occurs at the top of the river cliff, it may extend back over half-a-mile before it gives place to a—presumably overlying—layer of basalt. This occurrence is illustrated in section (Fig. 46).

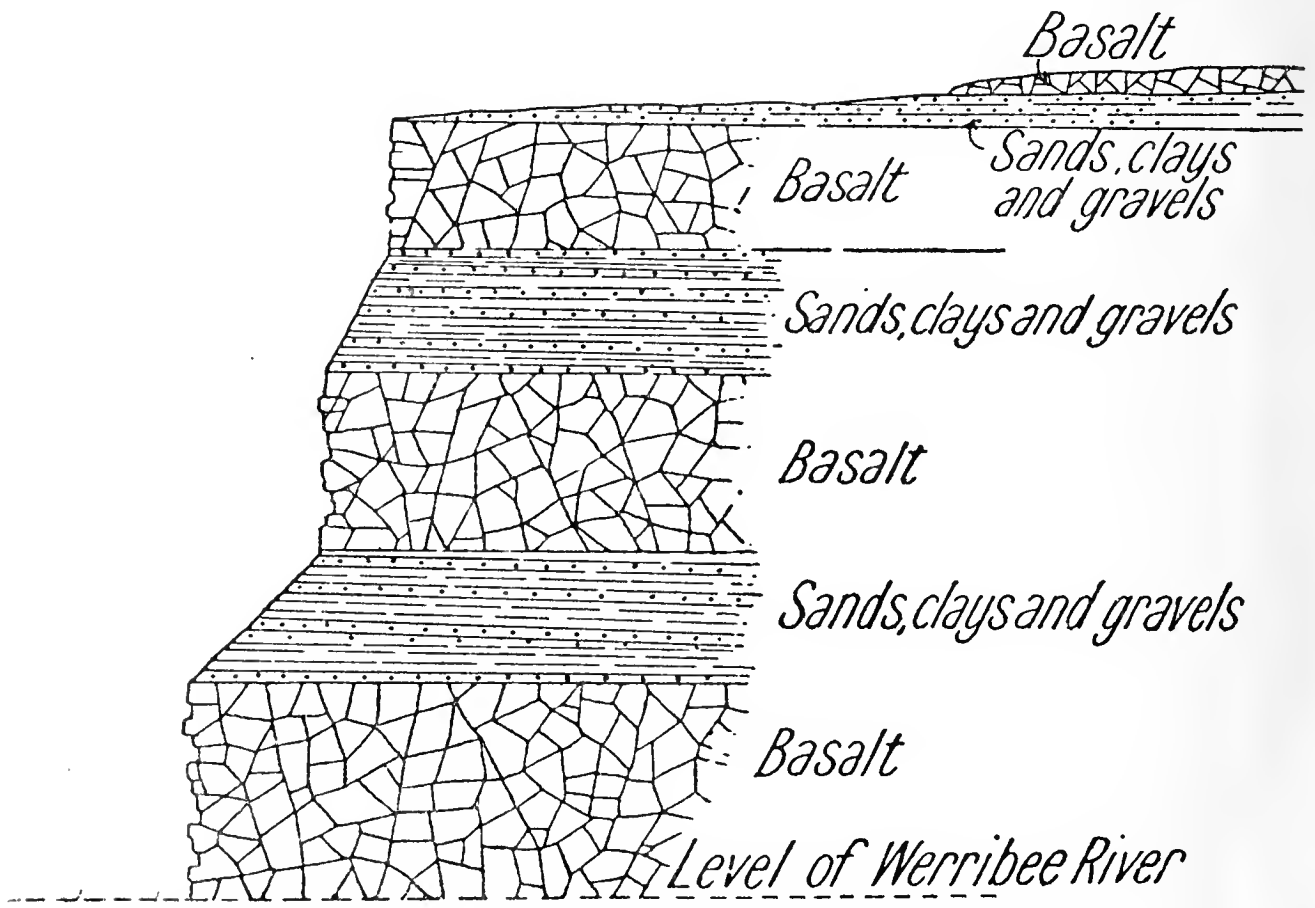


Fig. 46.—Section in cliff along Werribee River. Not to scale.

These layers in weathering mix with some basaltic soil and yield good crops when cultivated. No fossils were found in the Tertiary sediments, so there is no direct evidence of their age. The basalt is, however, without doubt part of the Newer Volcanic series, which fixes it as Pliocene, and since the sedimentary strata are inter-bedded with it they must also be Pliocene. In the adjoining quarter-sheet, No. 12 N.E., Tertiary beds inter-stratified with the basalt layers, are called Miocene. Down the river, on quarter-sheet No. 8 S.W., these beds are not shown, though they continue in the cliffs.

Post-Basaltic Sands.

In places the basalt is thinly covered with a layer of sand, which contains some grit or less frequently some gravel. This material has, in places, been derived from Tertiary sediments, but the decision of the age of it is complicated by the fact that in places the tuffs contain a considerable amount of sand, grit, and gravel, and recent weathering has made a capping on the tuff and basalt of good soil containing some sand, grit, and gravel. In allotment No. 20A, parish of Mooradoranook, some of the gravel appears to have been derived from a sedimentary bed, and some from the weathering of tuff. In allotment A of sec. XVII., parish of Mooradoranook, there are two small hollows, which may be water-holes in wet seasons, and at these a very small amount of limestone, possibly of fresh-water origin, was found.

Building Stone.

Much of the basalt exposed is decomposed, the harder stone, in places, is much honeycombed with steam holes, and some is platy in structure.

Some of the rock is fairly dense, and would do for building purposes, but no great thickness of even-grained dense rock was noted, such as might yield large blocks for landing purposes. Smaller stones suitable for buildings could be obtained from the upper flow, on the southern bank of the Werribee River about one mile north-westerly from the Parwan Railway Station, and also in other places.

Depth of Bedrock.

The depth of the bedrock was not ascertained anywhere in the area surveyed. No outcrops of Ordovician or Silurian rocks were noted. The geological sketch map of Victoria shows Ordovician rocks to occur on the north side of the Werribee River, in the parish of Djerriwarrah.

To the south and west of this survey, bores have been put down in search of water to 350 ft. without reaching bedrock. It was suggested to me that there may be a deep lead passing near or through the area surveyed.

Apparently all the water draining from Barkstead, Blakeville, and Blackwood must flow down the Werribee and Lerderderg Rivers, and pass down the Werribee River where it bounds this survey. No doubt sand and gravel from these places, and possibly some gold derived therefrom, or from reefs which may have existed nearer Bacchus Marsh, would also be carried down by the waters of the present, or ancient Werribee. Even if there is gold beneath the surface of the area surveyed, it is doubtful if it is confined to a defined channel or lead. We have no information concerning the configuration of the bedrock. The

nearest outcropping Ordovician rock to the survey south of the Werribee is at the end of the Brisbane ranges, near Rowsley, and this is 9 miles from the Ordovician rocks marked on the sketch map on the north of the Werribee River, parish of Djerriwarrah. There may be a defined river channel in between, but it is more probable that marine or estuarine deposits rest on the bedrock, and any gold contained in the gravels would be too widely distributed to be payable. To offer a more decided opinion on this question, a more extended examination of the country to the north and north-west would be necessary.

Caves.

In the parish of Parwan, about half-a-mile to the south-east of the Parwan Railway Station, there is a small cave. The opening is small, and the entrance is almost vertical for a few feet. On exploration, the cave was estimated to be about 20 ft. below the surface, and about 150 ft. in a horizontal direction. The air in the cave was light, and with a candle I could find no sign of a draught, indicating a passage leading from the chamber. The only rock noted was basalt. I am inclined to think that the cave was formed by subsidence, as there is a slight hollow at the surface; and below, some large blocks of basalt are broken across. There are no stalactites to be seen.

[26.3.12.]

SOME MINES AT DAYLESFORD.

By H. S. Whitelaw, Field Geologist.

The Lord Roberts Mine.

The reef now known as the Lord Roberts, situated 4½ miles south-west of Daylesford, was discovered by one Stevens over thirty-five years ago, and worked by him from the surface to 40 ft. in depth. Mr. Gilbert, manager of the Lord Roberts mine, informs me that after 400 or 500 tons had been crushed from the reef for an average return of half-an-ounce to the ton, it was abandoned owing to water troubles.

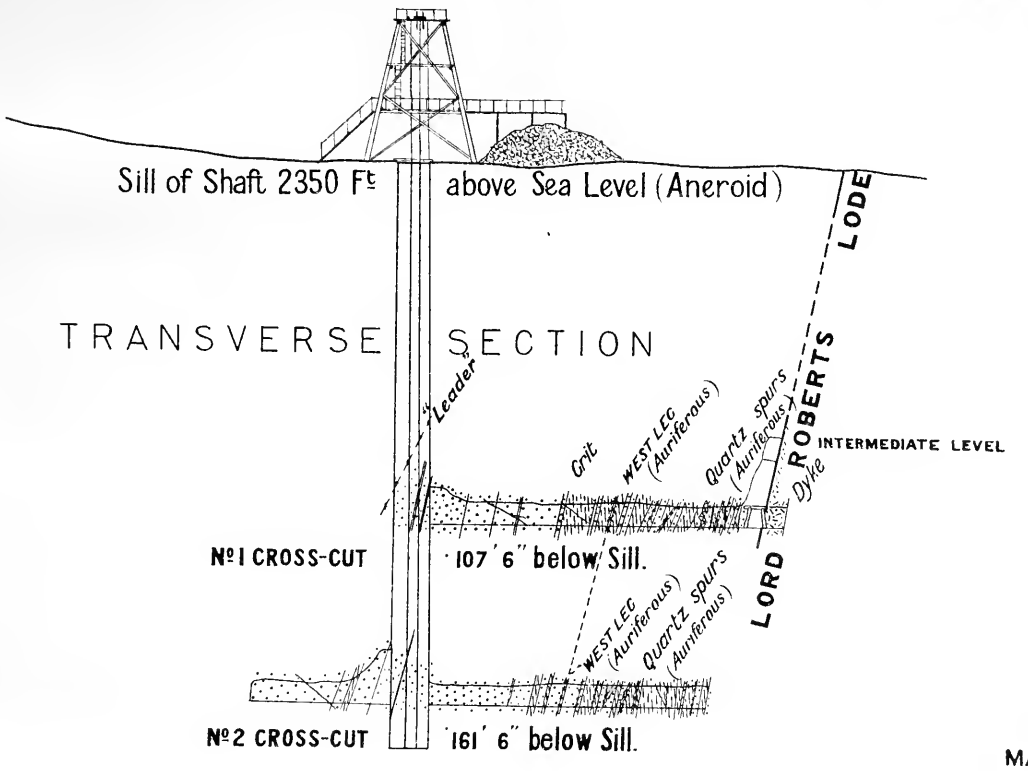
No further work was done on it until about sixteen years ago, when a sum of £200 was granted by the Government, under the provisions of the Mines Development Act, to C. Naples, who extended the old workings southwards, and proved that the payable run continued in that direction, but pitched under water at a point about midway between Stevens' shaft and the present Lord Roberts' shaft. The last crushing broken by Naples, Mr. Gilbert states, was one of 25 tons, which yielded 13½ oz. A little over two and a-half years ago the Lord Roberts Company was formed to work the reef below water level. A double 8-in. winch, a vertical 10-ft. by 5-ft. boiler, and 40-ft. wooden poppet-heads, with gear complete, were purchased and erected, and a 10-ft. by 4-ft.

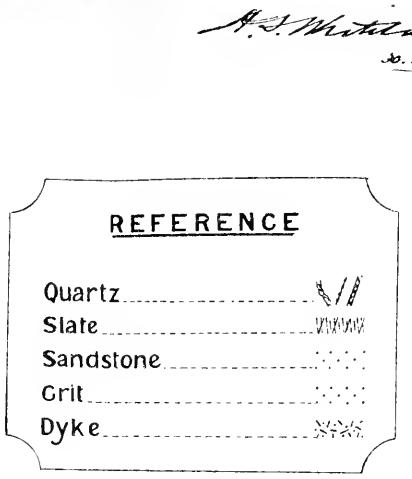
GEOLOGICAL SURVEY OF VICTORIA

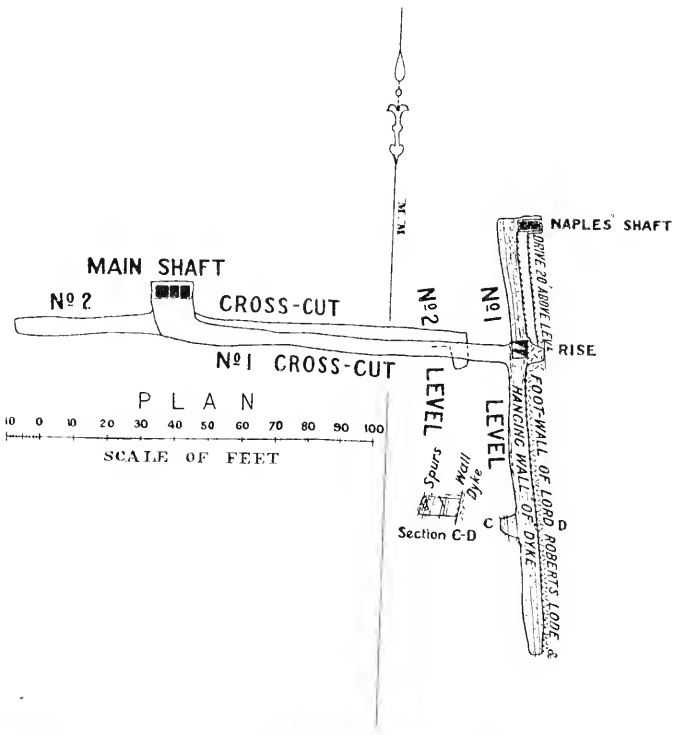
H. Herman, Director.
W. Dickson, Secretary for Mines.
The Hon A. Downward, M.L.A. Minister of Mines.

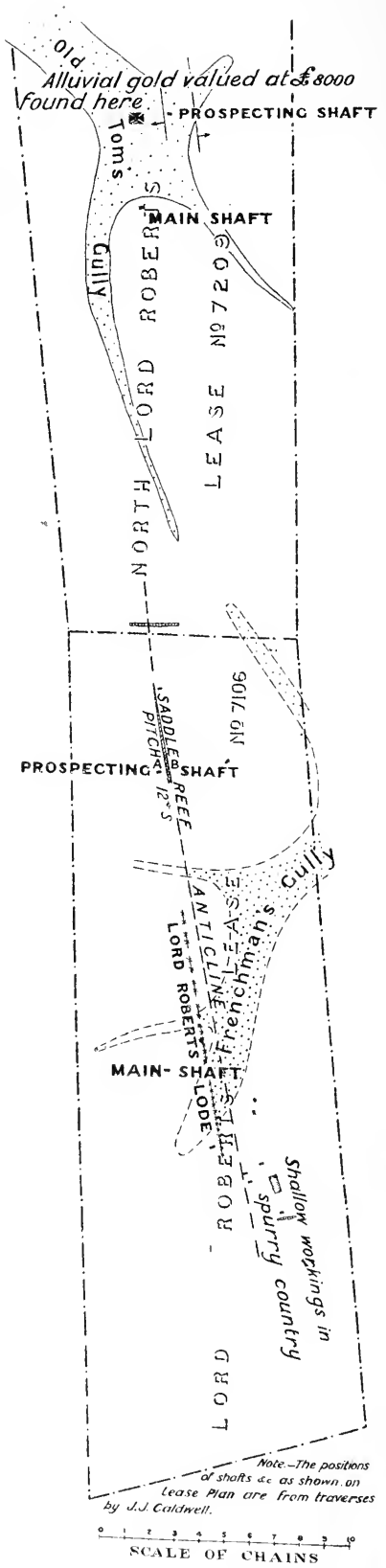
LORD ROBERTS MINE

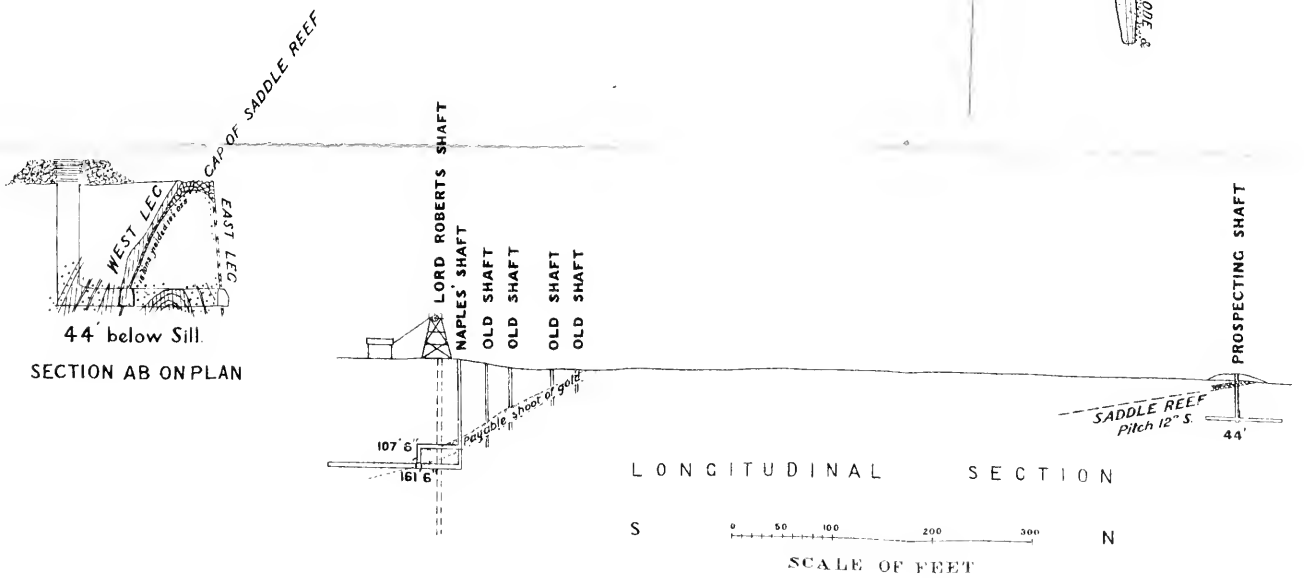
DAYLESFORD











shaft on the western side of the outcrop of the reef was sunk to 173 feet. At this depth the water, making at the rate of 4,000 gallons per hour, prevented further sinking with the present machinery, and, in consequence, cross-cuts were put out to the reef at depths of 107 ft. 6 in. and 161 ft. 6 in. (Pl. VIII.)

At the No. 1 level, after cutting through 8 ft. of breccia near the plat, a west leg 4 in. to 8 in. wide, carrying about 30 per cent. of sulphides, and estimated to yield 10 dwt. of gold per ton, was cut at 54 ft. from the shaft; and then about 30ft. of spurry country came in (all classed by the manager as payable crushing stuff). The cross-cut intersected the wall of the reef at 100 ft. east of the shaft. The value of the reef at this point and along the north level for 40 ft., taking it the full width of the drive, is estimated by the manager to be 3 dwt. per ton. The stone south of the cross-cut showed no improvement on this until the level had reached a point 40 ft. from the cross-cut, where values rose to 7 dwt. per ton. At between 50 ft. and 80 ft. from the cross-cut the reef is reckoned to be worth 10 dwt. to 12 dwt. per ton for a width of 12 feet, and between 80 ft. and 90 ft. (the end of the level) about 5 dwt. per ton for the whole width of the drive.

Near the end of the cross-cut a rise was put up for 21 ft. on the reef, and from the top an intermediate level was driven to the old workings from Naples' shaft in what the manager describes as "5-dwt. to 7-dwt. dirt." From the levels and rise 120 tons were crushed for an average yield of 10 dwt. per ton.

The longitudinal section of the workings shows the shoot to be less than 20 ft. in height, with a pitch of about 1 in 4 to the south.

In the shaft just above the No. 1 plat, a west-dipping "leader" was cut, and as it carried gold a cross-cut was driven west at the bottom level to intersect it. It would appear from the manager's record of the dip of the vein that the cross-cut, now 40 ft. in length, is out beyond the point at which the continuation of the leader should be found. Under this quartz vein is a bed of breccia 8 ft. wide composed of quartz grains (some of them partly rounded and as large as peas) and black slate, coursing through which there are several auriferous quartz veinlets. The eastern cross-cut at this depth (No. 2 level) is out 87 ft. from the shaft. In it the breccia, west leg and spurry country seen in the cross-cut above were passed through at the calculated distances, and at 80 ft. what was reported as the Lord Roberts lode-track was met with.

At both levels the track is an ironstone "casing" dipping at about 80° west, and that at the No. 1 level closely resembles that at the No. 2 level, but, after a careful examination of the inclosing beds and of the plat of the section of the mine, I am not at all certain that the one track is the continuation of the other. At the No. 1 level the footwall rock is a 5-ft. soft yellowish-brown band, while at the No. 2 level, only 54 ft. below, the rock under the track is a 2-ft. solid, quartzose band in no way resembling that at the higher level. I have little doubt that the rock under the track at the No. 1 level is a decomposed dyke, and that it has not yet been disclosed at the No. 2 level. To determine whether this is the case or not, the cross-cut should be extended. In

either case the driving of the cross-cut should be continued to the anticline (centre country), in which a saddle reef has been proved to exist.

The cap of this saddle reef outcrops at the surface at 800 ft. north of the main shaft, and from a crushing of 16 tons broken from the west leg immediately under the turnover the payable return of 10 oz. 10 dwt. was recovered. Later a vertical shaft was sunk to a depth of 37 ft., at a point 40 ft. west of the cap, and a cross-cut driven through the west and east legs. On the former, drives were put in for 45 ft. north and 30 ft. south, and a rise was put up to the cavity from which the crushing previously alluded to was extracted. Along the surface the east leg has been traced and sampled for a length of 300 ft. The average width is 2 ft., and the manager considers that the average yield from the portion tested will be about 10 dwt. to the ton.

It has been supposed that the west leg of this reef is the Lord Roberts reef, but that such is the case is improbable. The Lord Roberts reef, so far as it has been opened up, is conformable to the lines of stratification, and so resembles a leg, but it is associated with a dyke, with which it and the accompanying spurs are probably genetically connected, and may extend indefinitely in depth, whereas the west leg of the saddle reef is truly bedded, will become gradually attenuated in depth, and, before reaching the syncline, will probably thin out altogether. If the pitch (12° south) of the saddle reef is sustained over the stretch between the outcrop and the Lord Roberts shaft, the cap of the reef should be found a few feet below the depth of the present bottom level.

Southward from the main shaft shallow prospecting shafts have revealed the existence of numerous spurs or "flat-makes" pitching southerly at angles between 10° and 30°. In many of these visible gold is found, and from any of them Mr. Gilbert can wash promising prospects—from three or four spots prospects equal to 5 dwt. or 6 dwt. to the ton have been obtained. These veins could be attacked from a north level from the main shaft, and it is likely, when the mine has been further opened up, and after the erection of a ten-head battery (say, in about six months' time), which has been recently purchased, that attention will be given to this part of the lease.

The alluvial deposits in the vicinity obviously derived from the degradation of the Lord Roberts reef and spurs were, it is said, very rich, and it is thought by local miners that if water were available what remains of them would pay to sluice. Frenchman's Gully—the head of Bushy Gully, which falls into Sailor's Creek—whose source is at the Lord Roberts shaft, was rich in nuggets, and from the surface of Old Dick's Gully, 10 chains further south, and one of the heads of Sailor's Creek, £600 worth of gold was puddled immediately below where the reef crosses.

More prospecting than has yet been done will have to be carried out before it will be possible, with any degree of certainty, to estimate what the future of the mine is likely to be, but enough is known to justify serious exploitation. I would advise that, pending the erection of more powerful machinery, with which to sink to a depth where the products of decomposition pass over into sulphides (as has already

happened in the bedded veins, but not in the main reef), the No. 2 cross-cut be extended to the anticline, and a level driven south on the Lord Roberts reef to the continuation of the shoot of gold which pitched underfoot at the No. 1 south level; that a rise be put up on the west leg at 54 ft. east of the shaft at the No. 1 level; that the No. 1 south level be extended sufficiently far to command the system of spurs between Frenchman's Gully and Old Dick's Gully.

Indications point to the probability of the anticline being the principal reef channel, and later on it may be found to be advisable to sink a new shaft or to cut down and make a main of the prospecting shaft now down 37 ft. Observations taken along the line tend to show that this shaft was sunk near the crown of the fold—that point on the anticline from which the beds incline to every point of the compass, and around which, experience teaches, the greatest development of quartz and, generally, the richest yields are to be expected to be found. This spot, therefore, is a better site from which to work the channel of saddle reefs than that of the present main shaft, and as, at any rate to a depth of 40 ft., the axis of the anticline inclines to the westward, the shaft should be on that side of it.

[15.11.13.]

The North Lord Roberts Mine.

The North Lord Roberts main shaft is 35 chains north of the Lord Roberts shaft, and about 100 feet to the west of an anticline which probably is the prolongation of the fold in which the saddle reef referred to in the notes on the Lord Roberts mine has been worked.

The reef which it is intended to work was discovered at about the same time as the Lord Roberts, and is known, and shown on Mr. Hunter's Daylesford sheet (No. 16 S.E.) as Bell's Reef. Old reports state that it was remarkably rich; that a candle box full of specimens contained 92 oz. of gold, so peculiarly bedded in the quartz that they were exhibited at the 1880 Melbourne Exhibition; that the deepest shaft is 40 ft.; that from above that depth 1,500 tons yieded 2,000 oz.; that the last and deepest crushing averaged 12 dwt. per ton.

The new shaft at a depth of 36 ft. reached water making at the rate of 120 gallons per hour. Operations were then suspended, and will not be resumed until the erection of the machinery and poppet heads recently purchased from the Royal George mine, Bendigo. The shaft is in a good position for testing Bell's reef, which may be a west leg, below water level, and for working any formations that may be discovered in the anticline (centre country). The indications that saddle reefs will be found are strong; that some of them will prove payable is likely, for the reef channel is in the southward continuation of the Eganstown

auriferous belt, parallel to and about 2 miles west of the Ajax line, which, from stratigraphically lower levels, has produced large quantities of gold. This end of the belt has long been regarded as a promising field for mining enterprise, and there is now some hope of its being properly opened up. To the east of the Lord Roberts' leases there are numerous parallel deposits of quartz, some of them, notably Adam's reef, 70 chains to the east, 200 tons from which yielded 2,400 oz., or an average of 1 lb. of gold to the ton of quartz—have in places been worked with good results to water level. Below that depth, with the exception of Adam's reef, on which a 6 ft. x 4 ft. shaft was sunk to a depth of 400 ft., the reefs have not been followed. They continue below water level, and they can be traced for long distances along the surface, and generally, from their persistency and regularity, afford scope for systematic and continuous mining.

[15.11.13.]

O'CONNOR'S MINE, DRUMMOND NORTH.

By W. Baragwanath, Senior Field Geologist.

The present shaft of the O'Connor's mine is located to the west of and on a parallel line to the former main workings of the O'Connor's United mine. The line of reef was located in a tunnel driven in an easterly direction from Back Creek. In this tunnel a shoot of gold-bearing stone was followed down by a winze, and the main shaft was then sunk and a level opened out at 200 ft. in order to further test the reef. (Fig. 47.) At this level two distinct shoots of gold-bearing stone have been opened up, and a rise on the southern one proved that shoot to be distinct from the closely adjacent formation worked in the tunnel and winze. The north shoot was stoped over the 200-ft. level up to near the level of the tunnel. The shaft was deepened to 240 ft., and at 170 ft. from the shaft the line of the northern shoot was located and driven on. Stoping is now in progress between this level and the 200-ft. level, and a winze is being sunk below the main drive on a formation from 18 in. to 30 in. wide, showing fair gold. The lode formation consists of a well-defined fault or fissure dipping east at from 45° to 60°, and intersecting strata which dip from 60° to 80° west. The strike of the reef is from N. 15° W. to N. 20° W., while the strike of the strata is from N. 10° E. to N. 15° E. The intersection of reef and strata pitches north at about 1 in 4. The reef varies in width from a few inches, with several inches of crushed material, to 12 in. and 18 in. of solid, laminated, highly-mineralized quartz. The shoot of gold does not appear to be limited to one particular intersection, but more to a

favorable belt, as good prospects were obtainable over a height of 40 ft. from the bottom of the winze below the 240-ft. level, at the time of this inspection.

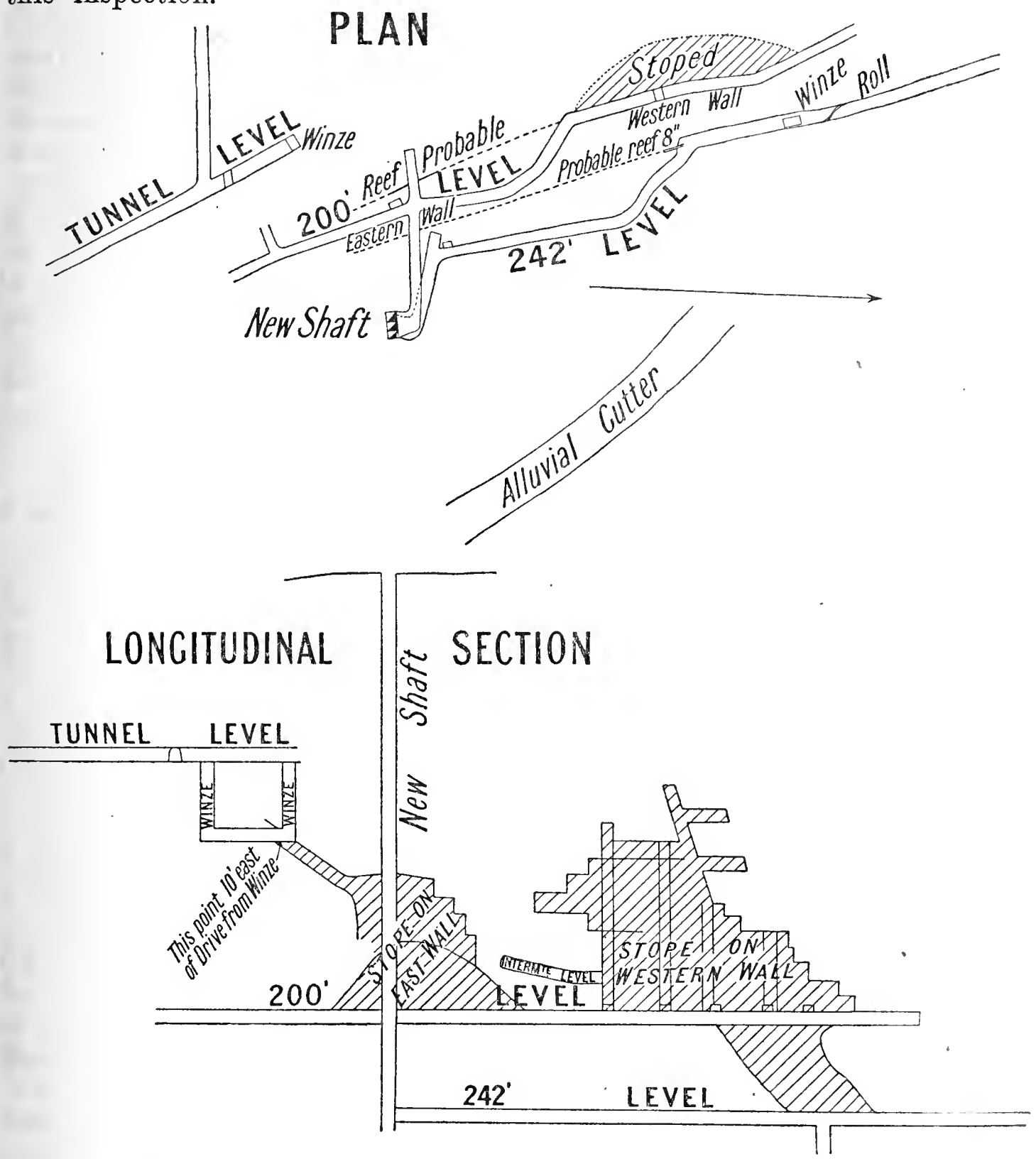


FIG. 47.—Plan and longitudinal section, O'Connor's Mine.
(Scale—100 feet to 1 inch.)

The southern shoot of gold-bearing stone at the 200-ft. level appears to me to be on a line parallel to the northern shoot, roughly forming a hanging wall and foot wall of a fissured belt from 10 ft. to 30 ft. in width, and across which counter-lodes occur. Such a counter-lode was followed north-westerly at the 200-ft. and 240-ft. levels, connecting the two formations. This counter-lode dipped northerly at from 40° to 45°, and more rapidly than the gold shoot, the true pitch of which has not yet been ascertained, but appears to be nearly vertical from the stope plan.

Future operations should lie in the direction of prospecting the proved formations, and should comprise a drive southerly on the lode track at the 240-ft. level, starting at a point 45 ft. to the south of the winze. This will prove the reef south of the intersection of the

counter-lode, and will be below the point where gold was left underfoot in the 200-ft. level. The extension west of the cross-cut from the shaft at the 240-ft. level should, within 20 ft., intersect this line of reef at a point 100 ft. south of where the drive suggested above would prove the lode. From the north face at the 240-ft. level a rise on the lode track would be good prospecting work. Developments at either of these suggested points will prepare the way for a definite development scheme which the prospects warrant, but which, with the present resources of the company, might be held over for the present.

So far as opened up, a shoot of gold-bearing stone over 120 ft. in length has been proved, but neither the northern or southern limits can be said to have been reached. Owing to the large quantity of mineral present at times, the gold values may be obscured, and a sampling of the reef might be undertaken with advantage.

With the exception of the works proposed above, operations within the resources of the company are proceeding upon good lines, but further prospecting is desirable, as, with a small lode development, work can easily overtake the ground opened.

It is rather unfortunate that a sink of only 40 ft. was undertaken below the 200-ft. level, as the amount of cross-cutting, &c., was not warranted, but I would suggest that the 240-ft. level be made the main level for prospecting, and the 200-ft. level abandoned for the present, and, if prospects warrant, a new level might be opened at 120 ft. in the shaft.

[21.5.15.]

NEW RED, WHITE, AND BLUE UNITED MINE, BENDIGO.

By H. S. Whitelaw, Field Geologist.

The conclusion I have come to, after studying Mr. W. H. Cundy's plans and spending the best part of a day in each of the mines, is that the New Red, White, and Blue United Company (afterwards to be called the Blue United) has not yet seen the main west back, on which, at and above the 1,790ft. level, the North Red, White, and Blue Company (afterwards to be called the North Blue) has been working, with payable results, for several years.

The North Blue and Blue United mines occupy positions on the Sheepshead line, similar to those of the Great Extended Hustlers and Hustlers Reef mines on the Hustlers line. The Great Extended Hustlers and the North Blue shafts are sunk on the northern rim of the crown of the respective anticlines—just where the country rock and the reefs commence their northerly pitch. In both of these mines the reefs in centre country are massive. In the Hustlers Reef mine to the north of the Great Extended Hustlers, the reefs—continuation of the Great Extended Hustlers reefs—are much smaller, and there is good reason to believe that the big reefs exposed in the North Blue workings will be found of smaller dimensions, not necessarily of poorer value, in the Blue United mine.

For a long time the main objective of the United Company has been the northward extension of the North Blue 1,710-ft. reef, the neck and cap of which reach from the 1,710-ft. to the 1,363-ft. level in the North

Blue shaft. Until recently it was considered that the workings at the 1,582-ft. level were deep enough to cut the North Blue shoot, but, after over 400 ft. of driving had been done at this depth, it was recognised that the reef, if it exists so far north, should be found at a greater depth. The work done at the 1,582-ft. level was not without value; most of it is practically in centre country, so close to it, at any rate, that over nearly the whole length reliable pitches have been obtained. These, when plotted on in Mr. Cundy's plans and read in conjunction with the pitch of the country in the North Blue workings, show beyond question that the beds in which the payable lower portion (the cap) of the reef is set in the North Blue have not yet been reached in the Blue United shaft, but though they point to this being the case, they do not show beyond doubt that the North Blue shoot of stone lies at a greater depth than the bottom of the shaft, 1,982 ft.

The position is this: There is a distance along the line of reef of about 2,015 ft. between the shafts. Of this length, the North Blue, at a depth of 1,790 ft., has opened up 1,040 ft. north from the shaft, and the Blue United, at a depth of 1,528 ft., has driven 415 ft. south from the shaft. In the North Blue the average pitch of the beds over 1,040 ft. is 10° N.; in the Blue United the average pitch over 415 ft. is 28° N. Between the two faces there is a stretch of 560 ft. of country, the structure of which we are entirely ignorant of, excepting that we knew that at the surface it pitches northerly. When the plot of the average pitch in the United is curved up through the unknown strip to the plot of the average pitch in the North Blue it is seen that the country in the face of the north drive at 1,790 ft. in the North Blue pitches underfoot at between 100 ft. and 200 ft. south of the shaft at a depth of 1,928 ft. in the Blue United. That fixes, approximately, the position of the rocks, but the difficulty in the way of placing, even approximately, the position of the reef is the fact that its pitch in the North Blue is apparently 5° or 6° less than that of the beds. For that reason it can hardly be called a saddle reef proper. Its lower portion—that part which rides on the so-called saddle—quite resembles that very rich false saddle in the Great Extended Hustlers, which further north—in the Hustlers Reef—became evenly bedded, and, as a saddle reef properly so-called, was worked pretty well throughout the length of the lease. I am inclined to the opinion that the North Blue reef will behave similarly, that somewhere inside the boundary of the Blue United—about where the pitch of the country reaches 20°—the neck of the reef will shorten—possibly the slide on which the neck is built will disappear altogether—and the shoot of stone in the shape of a saddle reef will continue northwards, and may be found by driving southward from the 1,928-ft. cross-cut in the Blue United.

Above the 1,928-ft. cross-cut there is a height of 180 ft. of unprospected ground, in which there is ample room for the occurrence of a saddle reef. This country could, and should, be prospected by a cross-cut from the plat cut at a depth of 1,902 ft.

A careful section of the 1,982-ft. cross-cut has been made, and compared with the beds bounding the North Blue reef. The beds do not match.

RED, WHITE, AND BLUE EXTENDED MINE, BENDIGO.

By H. S. Whitelaw, Field Geologist.

The Red, White, and Blue Extended mine is on the Sheepshead line, between Casley's Red, White, and Blue (to the south) and the True Blue mines, 3 miles south of Bendigo Post Office.

The shaft is 931 ft. deep (manager's measurement), and there are nine levels between surface and 900 ft. So far as can be seen, the only stoping done is above No. 2 cross-cut, on quartz on a fault, in centre country, and on an east leg south from the plat at 38 ft. to 64 ft. from the shaft. Centre country has been cut at every level, and numerous backs have been prospected, but only one saddle reef has been exposed, viz., about 15 ft. above the 800-ft. cross-cut, where an 18-in. cap has been uncovered by a rise on the east leg, in which gold was not seen.

Previous to the formation of the present company, the last work performed in the mine was at the 900-ft. level, where a winze about 10 ft. east of centre country was sunk about 10 ft. in a width of about 10 ft. of spurs on the west side of a dyke "lava." These spurs and the country rock in which they have formed are auriferous to the value, the present manager estimates, of between 2 dwt. and 3 dwt. to the ton. Operations ceased on account of water trouble, and the mine was abandoned about five years ago. Recently the present company reopened it, and commenced sinking the shaft (four compartments below 700 ft.), and 13 ft. 9 in. x 4 ft. over the timber.

All the conditions observable point to the strong probability of the existence of a reef at the depth mentioned, 1,000 ft. The auriferous spurs disclosed on the 900-ft. cross-cut, and in the winze below it, have almost certainly been deposited in country fractured by a strong east-dipping fault, which crosses the bottom plat, and they have the appearance, as they were followed downward, of forming the neck of a saddle reef, which may be found between 30 ft. and 40 ft. below the 900-ft. cross-cut. At this depth it would appear, from the pitch diagram of the line, published some years ago, that the shaft has just entered the zone of country in which, on the northern pitch of the channel, the Hercules and Energetic and Central Blue mines are working rich shoots, and the Ironbark, Victoria Consols, and Little 180 are breaking payable stone. Further, according to the manager who worked in the True Blue mine, the fault exposed in the Red, White, and Blue Extended 900-ft. cross-cut was profitably worked on a pitch of 12 in 100 north (the pitch of the country undulates throughout the Red, White, and Blue Extended lease), for a length of over 1,000 ft. between depths of 450 ft. and 500 ft. in the former mine.

[11.11.16.]

DIAMOND CREEK GOLD MINE, NILLUMBIK.

By A. M. Howitt, Field Geologist.

Geological.

The geological formations seen in the Diamond Creek mine are banded to normal shales, sandstones, and occasional narrow beds of quartzite and black slates, already determined as of Silurian age

(Melbournian or older).[1]. The strata dip 45° to 60° to the west, and strike north 22° east up to north 32° east, as showing in the No. 9 level. The Templestowe-Diamond Creek anticline passes by 22 chains to the east of the main shaft, but the dyke and reef would not intersect it until well over a depth of 2,000 ft., unless unforeseen faulting should carry the fold further to the west at a depth. Several different quartz occurrences have been proved in the mine, three of which are—

(*a*) Narrow laminated fault reefs, 3 in. to 6 in. in width, cutting the strata. These are, in places, highly auriferous, and were formed prior to the bedded veins and dyke reefs. They are known as "verticals."

(*b*) Narrow barren bedded quartz veins, laminated and vertically slickensided, and with which the slide faults are associated.

(*c*) The main auriferous reefs occurring in an extensive dyke (propylitic porphyry).[1] This class of reef has formed in shrinkage fissures on either the footwall or hanging wall side of the dyke.

The dyke strikes on the average north and south, and dips 45° to 50° to the east. It has intruded along a fault line, the fault breccia and conglomerate showing on one or both walls of the dyke, according to its direct association with the fault.

At times the dyke departs from the brecciated area (Fig. 48), and blocks of the breccia are now and then included in the dyke itself, showing that the fault and its breccia were formed before the dyke intrusion. In width the dyke is from 6 ft. to 30 ft. in places. It is jointed and slickensided, especially near the fault slides, which occur on the larger quartz-bedded veins and their associated black slate.

These fault slides carry the eastern-dipping dyke and reef back in a westerly direction (see Plate IX.). The different strikes of the dyke and the slides and their opposite dips give an intersection line pitching approximately north 20°. As the longitudinal and transverse sections show (Plate IX.), there are a number of these fault slides causing blanks of varying width. Besides these slide faults several cross-course faults have been met with in the deeper levels in the south workings of the mine. The quartz reefs generally occur several feet within the dyke, and have been more consistently rich when about 2 ft. or so away from the dyke walls.

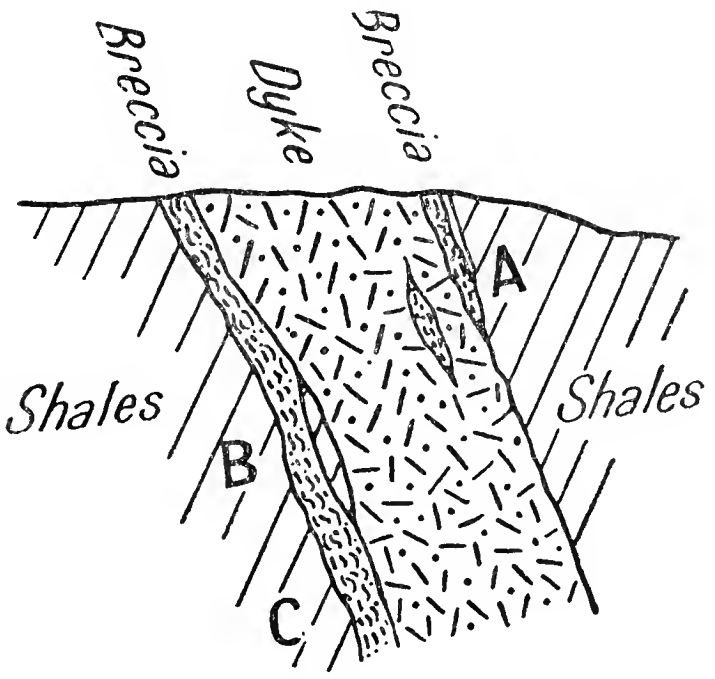


FIG. 48.—Sketch Section, showing—
A. Breccia within dyke.
B. Breccia away from dyke.
C. Breccia on dyke wall.

In thickness the quartz is from 1 in. up to 2 ft., but the average throughout the stoped ground would be from 6 in. to 8 in. wide. The payable quartz is always associated

[1] General and Mining Geology of the Diamond Creek Area, by N. R. Junner, B.Sc., Proc. Roy. Soc. Vict., Vol. XXV. (N.S.) pp. 525–553, 1912.

with stibnite (antimony sulphide), which occurs as dark streaks or crystal clusters. Three auriferous shoots have been profitably mined—

(1) The Union shoot, a footwall shoot pitching north.

(2) Day's shoot, a footwall shoot pitching north.

(3) The Whim shoot, a hanging wall shoot pitching north to vertical. (Plate IX.)

Of these shoots, the Whim has been the richest, and in the No. 8 north level the Day's and Whim shoots overlapped, giving a double reef, one on each wall of the dyke. In length, the payable quartz has been over 250 ft. in certain of the levels.

The bedded quartz veins are frequent above the 700-ft. level, especially at the 312-ft. and 414-ft. levels. The slide faults occur in the larger ones, the No. 3 slide fault showing a double 7-in. bedded vein with black slate between (Fig. 49). The narrower $\frac{1}{4}$-in. to 1-in. bedded quartz veins are seen in several levels to abut on the dyke walls, with a slight downward drag. (See Transverse Section, 500-ft. level, Pl. IX.). It follows that the series of bedded quartz veins, between any two fault slides, must meet the dyke walls also on a northerly pitch, thus those seen in the 312-ft. and 414-ft. cross-cuts would meet the dyke at the Union shoot above those levels, but meet Day's and the Whim shoots down to the 600-ft. north level. It therefore seems possible that a series of these veins may have had some bearing on the auriferous shoots, an enrichment already having been noted in the neighbourhood of the slide faults, which are on the larger bedded veins. The several auriferous vertical reefs, such as Grant's and Rechter's, may also have had some bearing on the shoots, but their relation could not be seen, except at the 312-ft. level.

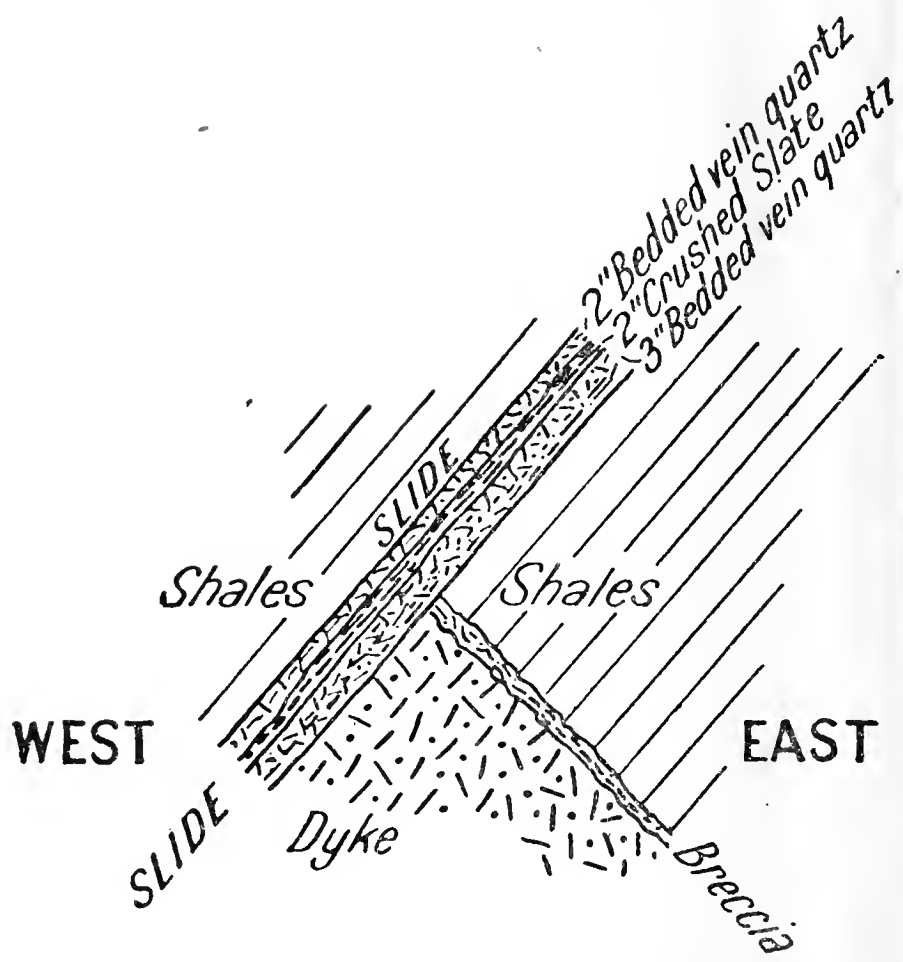
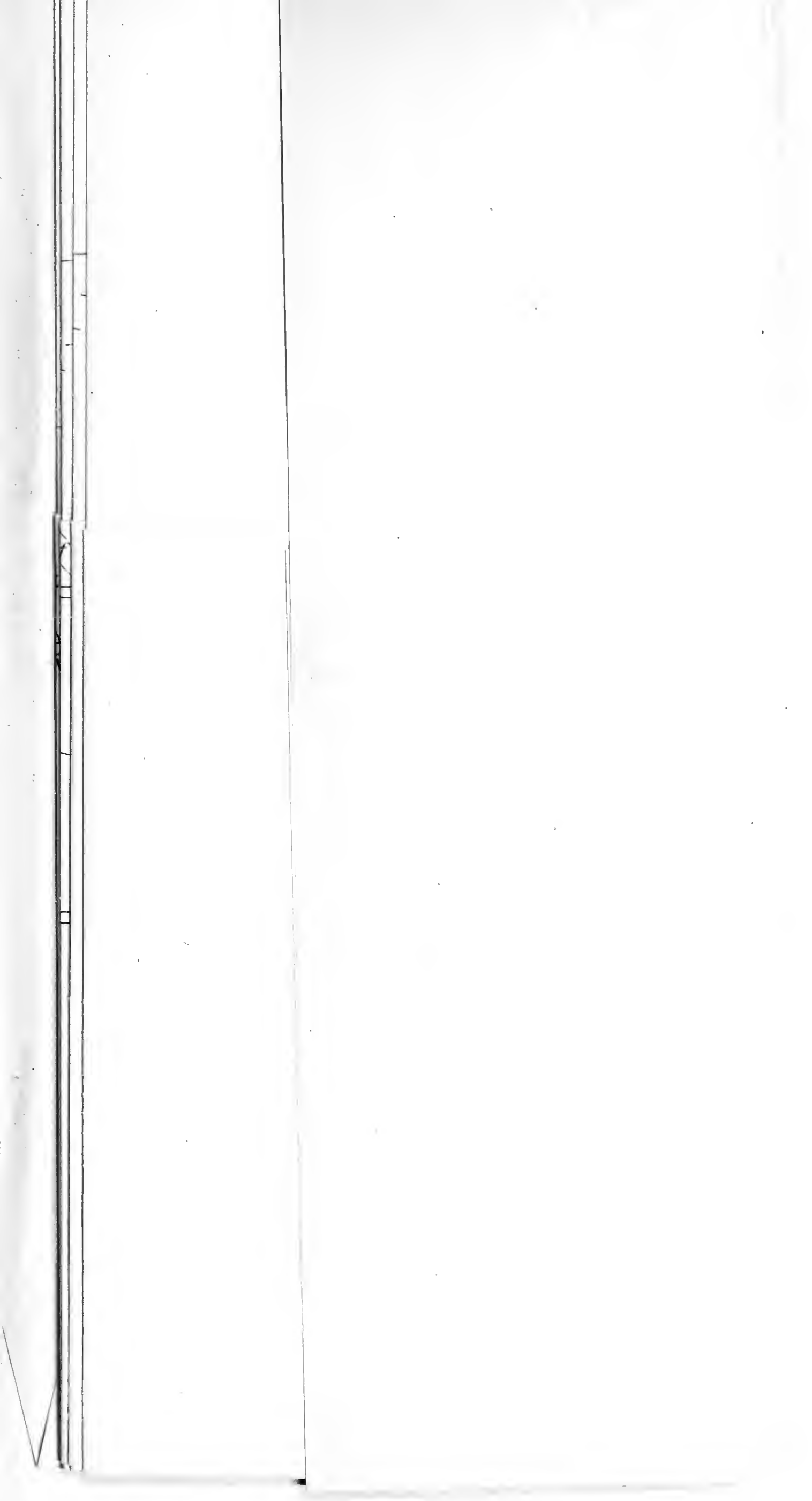


FIG. 49.—Double-bedded Vein on No. 3 Slide.
(Scale—3 feet to 1 inch.)

WORKINGS.

Some of the old drives were closed to inspection, but details were obtained throughout the lower levels with good sections in all the cross-cuts. The levels driven by the present company are at 312 ft.,



DIAMOND CREEK MINE

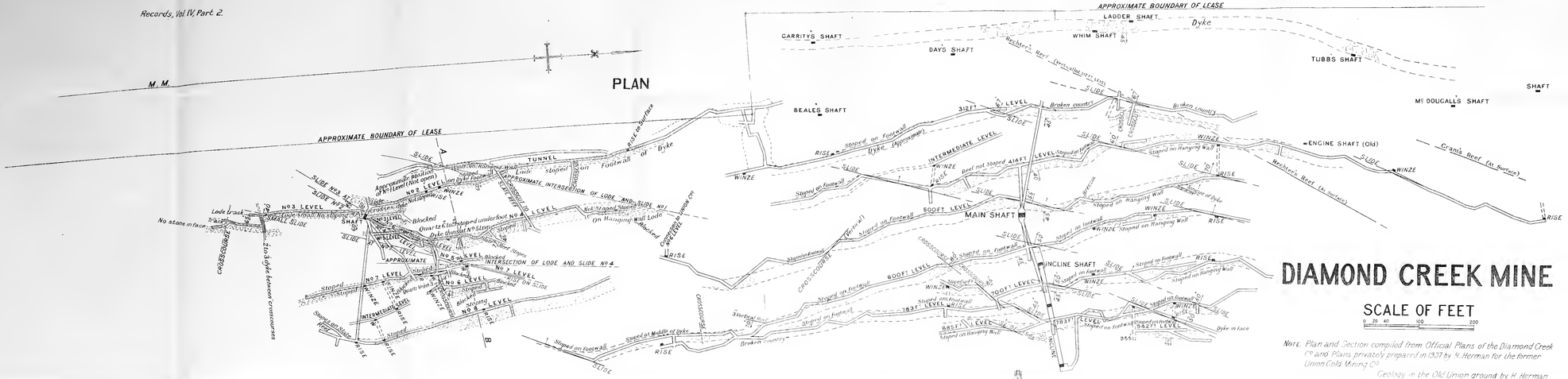
SCALE OF FEET

0 20 40 100 200

Note. Plan and Section compiled from Official Plans of the Diamond Creek Co and Plans privately prepared in 1907 by H. Herman for the former Union Cold Mining Co.

Geology in the Old Union ground by H. Herman 1907 and in the Diamond Creek Mine by A. M. Howitt 1914.

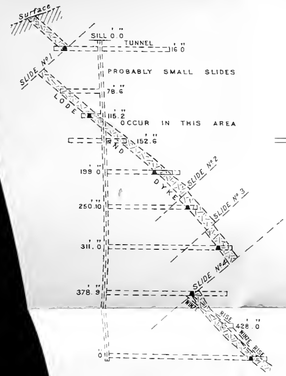
PLAN



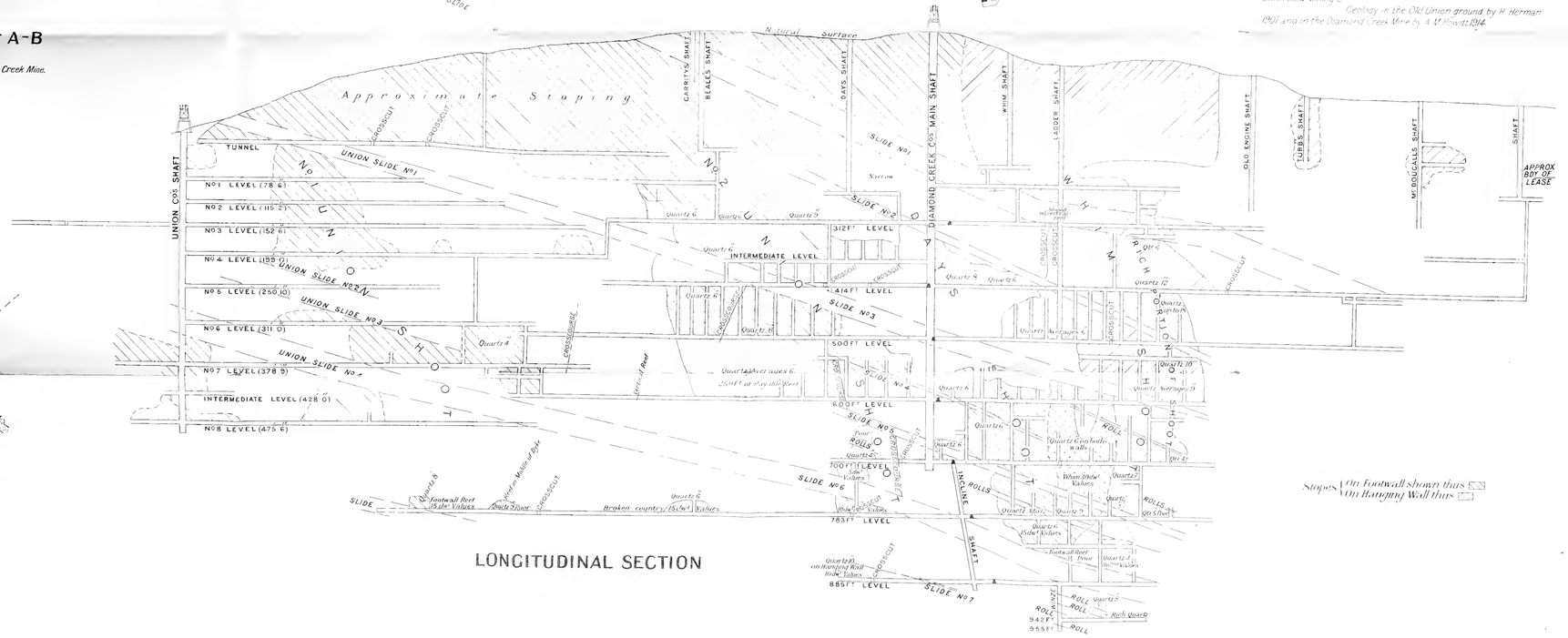
TRANSVERSE SECTION AT A-B

(NEAR OLD UNION Co's SHAFT)

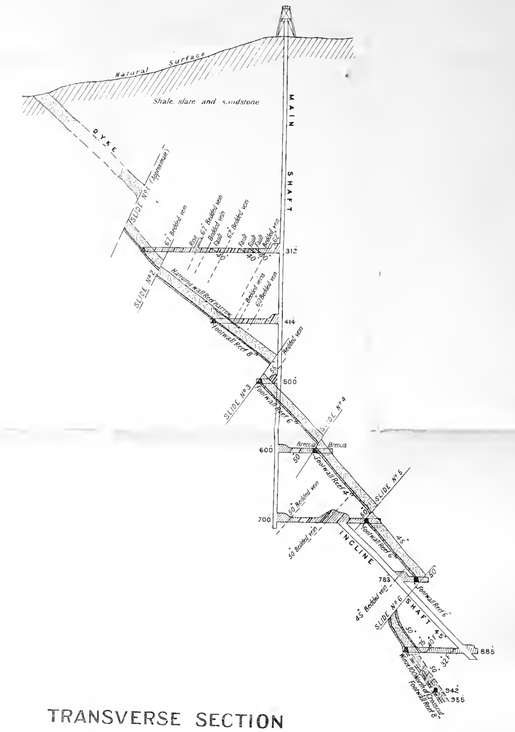
Note-Slide No 1 Union Co's Mine is slide No 3 in Diamond Creek Mine.



LONGITUDINAL SECTION



TRANSVERSE SECTION



TRANSVERSE SECTION

REFERENCE

Dyke | Sandstone | Shale and slate

Bedded quartz veins | Fault

414 ft., 500 ft., 600 ft., and 700 ft., from the vertical shaft, 783 ft. and 885 ft. driven from the underlay shaft, and the winze workings to 955 ft.

312-*ft. Level* (*No.* 3).—A cross-cut west cut the dyke footwall at 200 ft. and drives north and south were put in. The south drive is 546 ft. to the Union Company's boundary, and is connected with Beale's shaft by a rise. Payable quartz, 400 ft. in length and 6 in. to 9 in. in width is reported to have been mined in the stopes above this drive, which is now not open. The north drive is mainly in broken country, and was driven along an extensive fault slide. A vertical reef (Rechter's) is seen close to the fault and dyke (Fig. 50). Near this vertical reef a rich patch of gold was obtained in quartz spurs in the dyke. A considerable amount of prospecting was done from above the north drive with disappointing results. The yield from this level was 1,142 tons for 936 oz. mined from a reef averaging 6 in., and nearly all from the south end.

414-*ft. Level* (*No.* 4).—A cross-cut west 96 ft. proved the dyke to be 22 ft. wide, with a footwall reef 8 in. wide. The south drive, 552 ft. in length, cut a fault slide at 200 ft., which caused a blank in the drive of 98 ft., following which 9 in. of payable quartz was mined under the slide. The north drive exposed a 6-in. reef on Day's shoot (footwall), and then for 240 ft. a 6-in. reef was worked on the Whim shoot (hanging wall). Slide No. 1 came in at the north end, where much broken country occurred. A fair amount of work was also done above this level to test the McDougall's shoot, but results were disappointing. The yield from this level was 3,670 tons for 4,965 oz., from a reef averaging 8 in. to 12 in. in width.

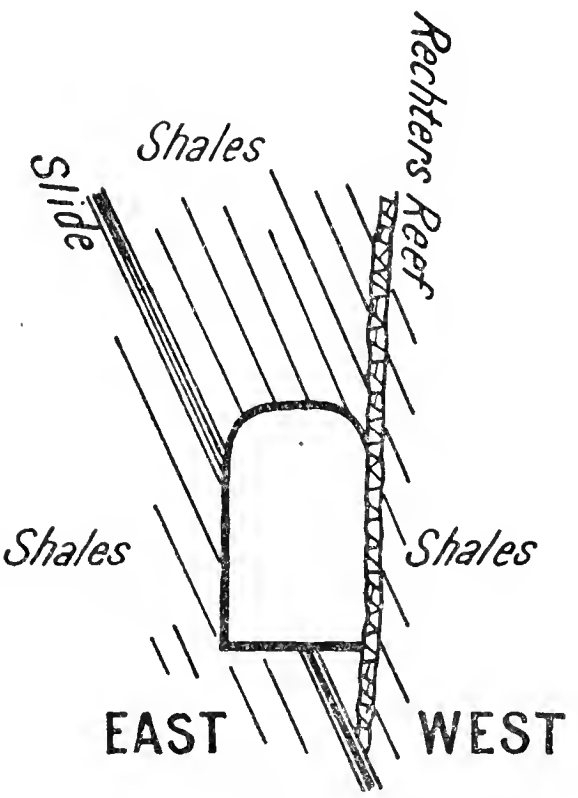


FIG. 50.—Rechter's Reef at the 312-ft. Level.

(Scale—10 feet to 1 inch.)

500-*ft. Level* (*No.* 5).—A cross-cut west 27 ft. cut the footwall of the dyke at 23 ft., and slide No. 3 in the end of the cross-cut. The south drive, 764 ft., exposed a 6-in. payable reef from 150 ft. to 294 ft., and connected with the No. 4 level, Union mine, by a rise. The north drive, 975 ft., was in the slide for about 60 ft., and then cut the Whim shoot at 230 ft. Slide No. 2 was cut near the north end of the stopes. The yield from this level was 4,820 tons for 5,934 oz., crushed during 1909-1910.

600-*ft. Level* (*No.* 6).—A cross-cut, 81 ft., cut the dyke 30 ft. in width, and the re-make of Day's shoot, showing 4 in. of payable quartz. The south drive, 744 ft., connected with the No. 7 level, Union mine, where there was 6 in. of fair to payable quartz. In this drive 250 ft. of payable quartz was mined on the footwall, Union shoot. The north drive was put in 446 ft., passed through the No. 4 slide, and then through 6 in. of payable quartz. Day's shoot was stoped a little from this

level, and the Whim shoot for 220 ft., with the No. 3 slide in the middle of it, where cut in the drive. The north end of these stopes yielded very rich quartz. The yield was 1,152 tons for 1,100 oz., mostly from the south end, and crushed during 1911.

700-*ft. Level* (*No.* 7).—A cross-cut, 151 ft., cut the dyke, 16 ft. wide, at 129 ft., carrying a 6-in. footwall reef. A south drive, 188 ft., met a cross-course at 95 ft., which displaced the dyke for 20 ft. to the west. The re-make of dyke carried 4 in. of 5-dwt. quartz (unpayable), and work here was discontinued. The north drive, 460 ft., proved 9 in. of footwall reef (Day's shoot), and at 150 ft. north of the cross-cut a parallel drive was put in on the hanging wall reef (Whim shoot), the two reefs running side by side for over 100 ft. in length. Yields from this level were 3,878 tons for 5,575 oz., crushed during 1912.

783-*ft. Level* (*No.* 8).—A cross-cut, 50 ft. in length, cut the dyke, 20 ft. wide, at 20 ft. from the shaft, where it carried a 6-in. reef, occurring in hard strata. The south level, 938 ft. in length, cut slide No. 6 at 18 ft., and passed through blank country for 70 ft. in the drive; the re-make of the dyke carried a 6-in. reef worth 10 dwt. to the ton. A rise was put up to the 700-ft. level, and some stoping below and above the slide was done. From 400 ft. to 500 ft. more stoping was done on a footwall reef 6 in. wide, proving 15 dwt. values, up to the break. A reef, 150 ft. from the south face, near the middle of the dyke, was stoped recently, and gave fair prospects. In the south face (Fig. 51) and at a short distance back from it, 8 in. of footwall quartz was also stoped with good prospects, as shown on the longitudinal section (Pl. IX.) The north drive, 400 ft.

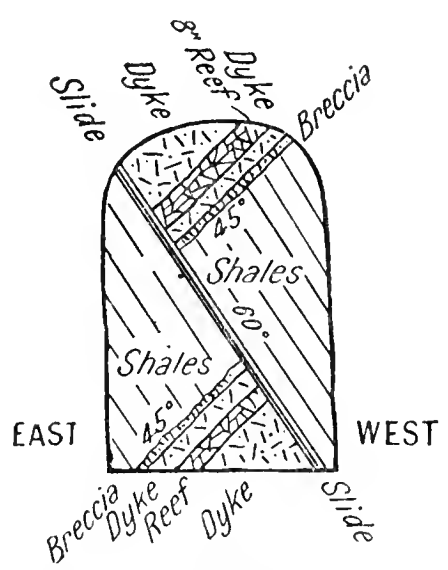


Fig. 51.—Section of South Face, 783-ft. Level. (Scale—6 feet to 1 inch.)

in length, worked Day's shoot, 9 in. wide, and this was payable. The extreme north end was in broken country, and several small rolls (minor slides) were cut. The Whim shoot only came down to slide No. 5, and it carried 8 in. of poor quartz above it. (Fig. 52.) The yields from this level were 3,984 tons for 4,951 oz. The average width of the reef was 8 in.

885-*ft. Level* (*No.* 9).—A cross-cut, 110 ft., cut the dyke, 25 ft. wide, carrying a little poor quartz on both walls.

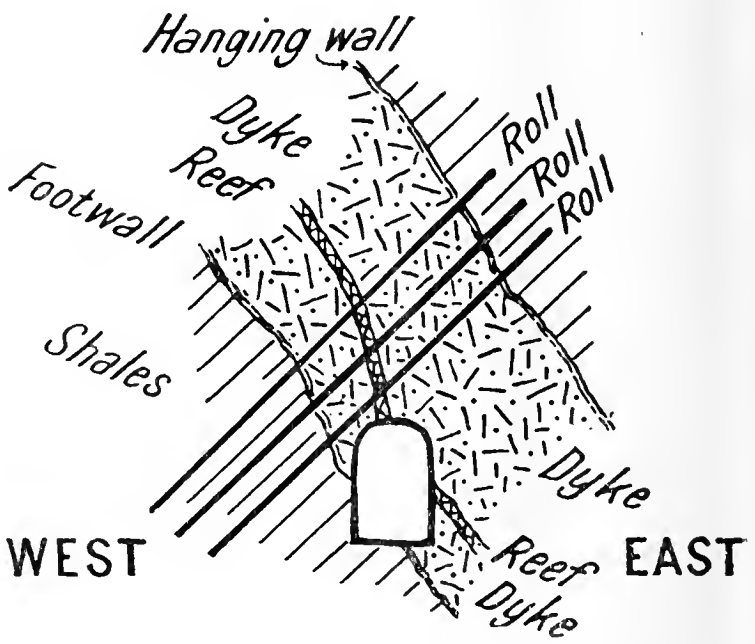


Fig. 52.—Rolls, or Minor Slides, at the 783-ft. Level. (Scale—16 feet to 1 inch.)

The south drive followed the footwall of the dyke, and cut a small slide at 91 ft. from the cross-cut. The prospects improved, and were very promising for a few feet, but crushings from the south end returned only 5 dwt. to the ton. The north drive (Fig. 53), 299 ft., cut the large slide, No. 6, and in two places along it patches of dyke and reef were passed through, a somewhat similar occurrence to that in the No. 1 slide (312-ft. level). In this drive there was poor quartz from the cross-cut to the winze. The winze was sunk 92 ft. on the underlay, and at 72 ft. down a drive north was put in for 148 ft. on the footwall of the dyke, and at 40 ft., in 8 in. of payable quartz (1 oz. to 4 oz. to the ton) was stoped for a length of about 40 ft. by 25 ft. above the level. The dyke in the winze (Fig. 54) and along this level was disturbed by several rolls. This payable stone is still going underfoot, but the expense of working in this winze, which was very wet, caused operations to be suspended. The reef in the winze workings was promising, and was richer than anything seen below the No. 8 level.

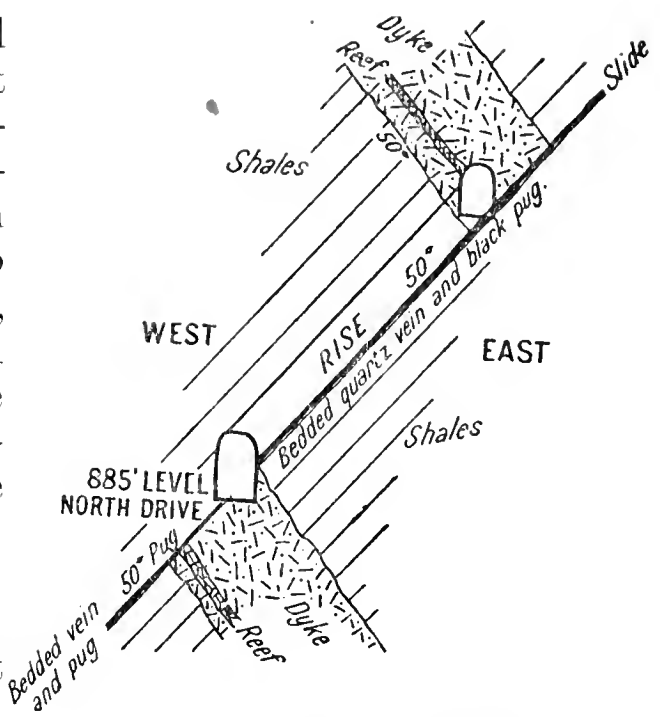


FIG. 53.—Section showing Displacement of the Dyke on Slide, 885-ft. Level.
(Scale—40 feet to 1 inch.)

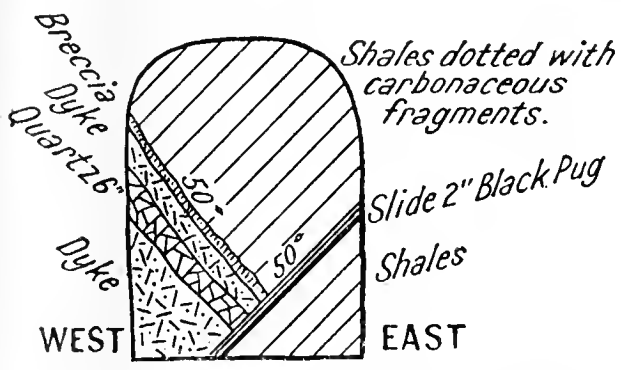


FIG. 54.—Section of Face in North Drive from Winze below the 885-ft. Level.
(Scale—8 feet to 1 inch.)

GENERAL.

The prospects at the No. 8 level south are favorable, there being payable quartz at the second stopings south, and highly encouraging prospects near the face. The reef at the No. 6 level south was payable, and the stone is still going underfoot, the ground south, between the No. 6 and No. 8 levels, being practically untouched. No. 7 level south would also test some of this reef known to be going underfoot at the No. 6 level. When connexion is made by rising with the south workings above the No. 8 level, ventilation will be more satisfactory, and work would be facilitated. The No. 9 level should be extended north, as there is evidence of the dyke and country under the No. 5 slide having moved to the north (see cross-course on longitudinal section, Pl. IX.), and besides that, none of the levels below the 500-ft. level have been extended far past the Whim shoot. The No. 9 level, south drive, is in poor quartz at the present time, and would have to be driven 200 ft. further south to get under the payable reef at the No. 8 level (second stopes south). The country is very much disturbed and broken at the No. 9 level, but the winze workings seem to be somewhat more settled, and the country passed through at No. 8 level south indicates that no large breaks are likely to be encountered for at least 150 ft. below the No. 9 level north. To open the mine at a further depth, a more economic scheme of working than by the two shafts should be provided.

The following gives total yields from the Diamond Creek mine:—

Date.	Tons.	Oz.	Dwt.	Level.	Width.	General.
				Feet.	Inches.	
1907, July ...	493	514	7	312	—	—
1908, Jan. ...	649	421	17	312	6	—
1908, Jan. ..	395	520	2	414	12	—
1908, July ...	1,632	2,696	13	414	—	—
1909, Jan. ...	1,643	1,748	8	414	8	1,170 tons, south end
1909. July ...	1,691	2,225	1	500	8	588 tons, south end
1910, Jan. ...	1,740	1,613	9	500	7	511 tons north end
					8	728 tons, south end
1910, July ...	1,389	2,085	10	500	6	519 tons, north end
				600	4	377 tons, north end
						133 tons, south end
1911, Jan. ...	1,906	2,913	11	500	4 to 8	1,000 tons, north end
				600	8	Whim shoot, rich
1911, July ...	1,152	1,100	6	600	6	530 tons, south end
1912, Jan. ...	1,869	2,740	0	700	3 to 18	1,564 tons, north end
1912, July ...	2,009	2,835	13	700	6	1,635 tons, north end
1913, Jan. ...	1,875	2,776	15	400	9	453 tons, north end
				700	6	700 tons, north end
				783	8	739 tons, north end
1913, July ...	2,407	3,277	11	783	8	1,964 tons, north end
1914, Jan. ...	1,577	1,673	18	783	7	688 tons, north end
1914, June ...	736	690	0	783	6	92 tons, north end
						323 tons, south end
				885	8	61 tons, south end
						260 tons, north end
Total Yield ...	23,163	29,833	1			

The ore crushed included 30 per cent. of dyke rock (the width above refers to quartz only).

The dividends paid to July, 1913, amounted to £12,250, or 7s. per share.

[8.7.14.]

Diamond Creek Gold Mine.

In July, 1914, the Diamond Creek Gold Mine was taken in hand by the Diamond Gold Mining Company, and worked until January, 1915, when mining operations ceased, the plant having been destroyed by fire.

During this period, July, 1914, to January, 1915, the following crushings were obtained:—

Level.	Tons.	Ozs.	Dwts.	Grs.	Date.
No. 8. South end—(Union shoot) ...	118	38	8	9	July, 1914
No. 9. North end—(Day's shoot) foot-wall reef	52	36	0	7	Aug., 1914
No. 9. North end—(Whim shoot) foot-wall reef	88	84	12	0	Sept., 1914
No. 9. North end—(Whim shoot) foot-wall reef	90	74	18	18	Nov. 1, 1914
No. 9. North end—(Whim shoot) foot-wall reef	66	147	13	0	Nov. 13, 1914
No. 9. North end—(Whim shoot) foot-wall reef	86	165	13	0	Dec., 1914
No. 9. South end—(Union shoot) ...	62	33	10	13	Jan. 1, 1915
No. 9. South end—(Union shoot) ...	80	38	0	0	Jan. 15, 1915
Cleaning of plates	...	34	0	0	
Total	642	652	15	23	

Besides these yields there were 7 tons 7 cwt. of pyrites concentrated, which were sold for £3 3s. 6d. per ton (£23 6s. 8d.). The battery sand was sold to a private cyanider for 1s. 9d. per ton, with an additional charge of 3d. for steam, making 2s. per ton.

Stoping has been carried on continuously since the new company took charge, and only 50 ft. of additional driving was done—this at the No. 8 level south along the break.

[4.2.15.]

OUTCROP OF COAL NEAR FOSTER.

By S. B. Hunter, Engineer for Boring.

A coal outcrop is situated close to the north boundary, and about 20 chains eastward from the north-west cornèr of allotment 22B, section C, parish of Wonga Wonga South. Where tested by a small tunnel, the coal is somewhat faulted, and consequently soft, through crushing. The quality appears to be excellent, and an analysis made some time ago by this Department of a sample forwarded by Mr. Baker, the discoverer, proved it to be high in fixed carbon and low in ash percentages.

Mr. Baker informed me that about 30 ft. to the west of the outcrop he sank a hand bore, and proved nearly 5 ft. of coal. A Government bore sunk in 1896, three-quarters of a mile away, in a north-easterly direction, proved 5 in. of coal at 474 ft. and 1 ft. 10 in. of coal at 750 ft. deep. It is probable that the 1-ft. 10-in. seam is a continuation of the seam on the dip, although the depth (750 ft.) indicates that faulting down, in addition to the natural dip of the strata, has occurred.

[21.4.14.]

TYRELL'S REEF, BLACK RANGE, EDI.

By A. M. Howitt, Field Geologist.

Tyrell's gold mine is situated in the parish of Edi, county of Delatite, on the top of a steep ridge in the Black Range country, about $4\frac{1}{2}$ miles in a direct line to the east of Whitfield township.

The containing strata are predominant sandstones and occasional dark-grey to blue slates, dipping from 60° to 70° west, and striking N. 35° W. These strata are of Upper Ordovician age, and show contact metamorphism along the course of an extensive mica-diorite dyke, associated with which are the auriferous quartz veins.

In 1897, when first found, a surface quartz outcrop was prospected with fair results, and Tyrell and party put in a tunnel for a distance of 298 ft.;[1] at the same time sinking several shallow shafts, of which one cut the tunnel and was used as an air shaft (50 ft.). Several thin quartz veins in the dyke were prospected, and eleven samples weighing from 5 lb. to 12 lb., gave returns equal to $4\frac{3}{4}$ to $5\frac{3}{4}$ dwt. per ton. Three crushings of 1 ton each gave respectively 10 dwt. 13 gr., 3 dwt., and 3 dwt. per ton.

Nothing further was done until 1911, when the present party was formed to prospect the mine close to the old main open cut. In this open cut an eastern dipping quartz lens, 1 ft. wide, was seen on the dyke footwall. Two tons were taken out and crushed at Rutherglen for 7 dwt. 12 gr. per ton, and two tons at Bendigo for 8 dwt. 12 gr. per ton.

In 1912 a Government grant of £100 was allotted to the party to further prospect by sinking and driving towards the open cut workings. The shaft has now been sunk 50 ft. in the dyke and a level driven south-westerly for a distance of 57 ft., where a sandstone formation was cut and work discontinued. Opposite the shaft a branch drive south was put in 22 ft. without proving anything of value, and at 11 ft. from the shaft another branch drive was put in north-westerly to follow a 6-in. quartz vein dipping 30° east. Samples from this vein were taken during the inspection and assayed at the Geological Survey laboratory.

No.	Description.	Gold.			Silver.			Remarks.
		oz.	dwt.	gr.	oz.	dwt.	gr.	
406	Quartz 4 in. thick.. ..	0	1	23	0	0	16	
407	Wall of same, 1 in. each side	0	1	7	0	0	16	
408	Diorite, 1 in. each side ..	0	0	16	0	0	16	
	Total, vein 8 in. thick from north-west drive	0	3	22	0	2	0	
405	Quartz at 32 ft. deep in main shaft	0	2	15	0	0	16	
410	Quartz vein from south shaft near surface	0	5	21		trace		
411	A picked mineralized specimen from dump at open cut	1	13	23	0	11	2	Contained stibnite, arsenopyrite and galena.

There is nothing to show which way the main auriferous vein pitches, but most of the larger veins at the surface occur to the south of the open cut workings, suggesting that the larger veins may also be in that direction.

I consider that the sandstone wall cut in the main level should be driven on south-easterly to prove if the main contact surface vein extends that way; the quartz vein in the branch drive should also be further prospected. Although the above assays are not payable, the vein being so narrow, it might increase in width, and possibly connect with the open cut. On the whole the quartz veins are of the lens type, very irregular and apparently short in extent, but not one of them has yet been thoroughly prospected. If favorable developments should at any time take place, further work by means of the old tunnel could be undertaken.

[11.9.13.]

[1] Gold Occurrences, Upper King, by James Stirling, Mon. Prog. Rept. No. 9, 1899.

PHOSPHATE OF IRON AND OTHER MINERALS, WHITFIELD DISTRICT.

By A. M. Howitt, Field Geologist.

In 1905, on my return from a visit to Whitfield[1], I submitted to the Geological Survey laboratory a ferruginous specimen showing the presence of phosphoric acid, and the result of the analysis was 10 per cent. of phosphoric anhydride. Subsequently the ridge, from which the specimen came, was prospected and the lode discovered.

This lode was found on a main ridge between Stoney Creek and the King River, and has been traced for 150 ft. in length by several small prospecting cuts. The lode strike is W. 33° N., and its dip west to nearly vertical, conformable to western dipping sandstones and slates of Upper Ordovician age. Four chains east and higher up the spur there are eastern dipping strata, which are the northerly continuation of the Mt. Avis turquoise beds, from which Upper Ordovician graptolites were formerly recorded.

An interesting feature is that on the eastern side of the anticlinal fold at Mt. Avis, Whitfield, the turquoise (phosphate of alumina) occurrences are secondary to, but nearly always associated with, iron pyrites in small fissures and nodules, whilst in the same beds further to the north, and on the other side of the fold, there appears to be no pyrites or turquoise, but a combination of iron and phosphoric acid, occurring as a vein or lode of basic phosphate of iron (dufrenite)[2].

As at present exposed the lode varies from a few inches up to 1 ft. in width, and some of the richer portions yield up to 31.54 per cent. of phosphoric anhydride (analysis No. 413). The top or southerly prospecting cut is 4 ft. across the strata, and here the rich ore is only narrow and pinching out going south. The middle cut 26 ft. further to the north-west is 5 ft. across the strata, and 3 ft. deep, proving 2 in. of rich ore and 6 in. of poor ore bounded by slate and sandstone showing traces of phosphates. The main cut and the 6 ft. shaft are 120 ft. further to the north-west, and here up to 1 ft. of ore has been proved.

At present the amount of rich ore is too small to be of commercial value as a phosphate, but further prospecting may prove other adjacent veins. The ore might be of value as a pigment, as when ground it produces a dark-green colour, with a moderate covering power (see analysis No. 400). The occurrence is of value, as it proves that rich phosphate of iron in lode form may occur in other localities in Victoria amongst the extensive areas of Upper Ordovician rocks, which are in many districts little known from a mineral aspect. The ore is itself of interest, having been determined by complete analysis (No. 413) as indicating dufrenite (basic phosphate of iron), new to the list of Victorian minerals.

Some Mineral Occurrences at Whitfield.

At Mt. Pleasant, about 8 miles to the south of the township, an examination was made of a series of Carboniferous strata nearly horizontally bedded, and dipping 3° south-east. (Fig. 55.) The mount shows a series of steep cliffs of sandstone and thin impure limestone beds, relieved by short slopes where red to brown mudstones outcrop on the northern face, very similar to the beds at Mt. Battery, in the Mansfield

[1] Edi-Myrhee Turquoise Belt, by A. M. Howitt, Rec. Geol. Surv. Vict., Vol. I. Pt. 4, p. 239.
[2] See appended analyses.

basin. At the foot of the mount the sandstones contain plant fossils, some apparently of the Lepidodendron type, and near the summit plant fossils were also noted, and a fine example of ripple-marked sandstone.

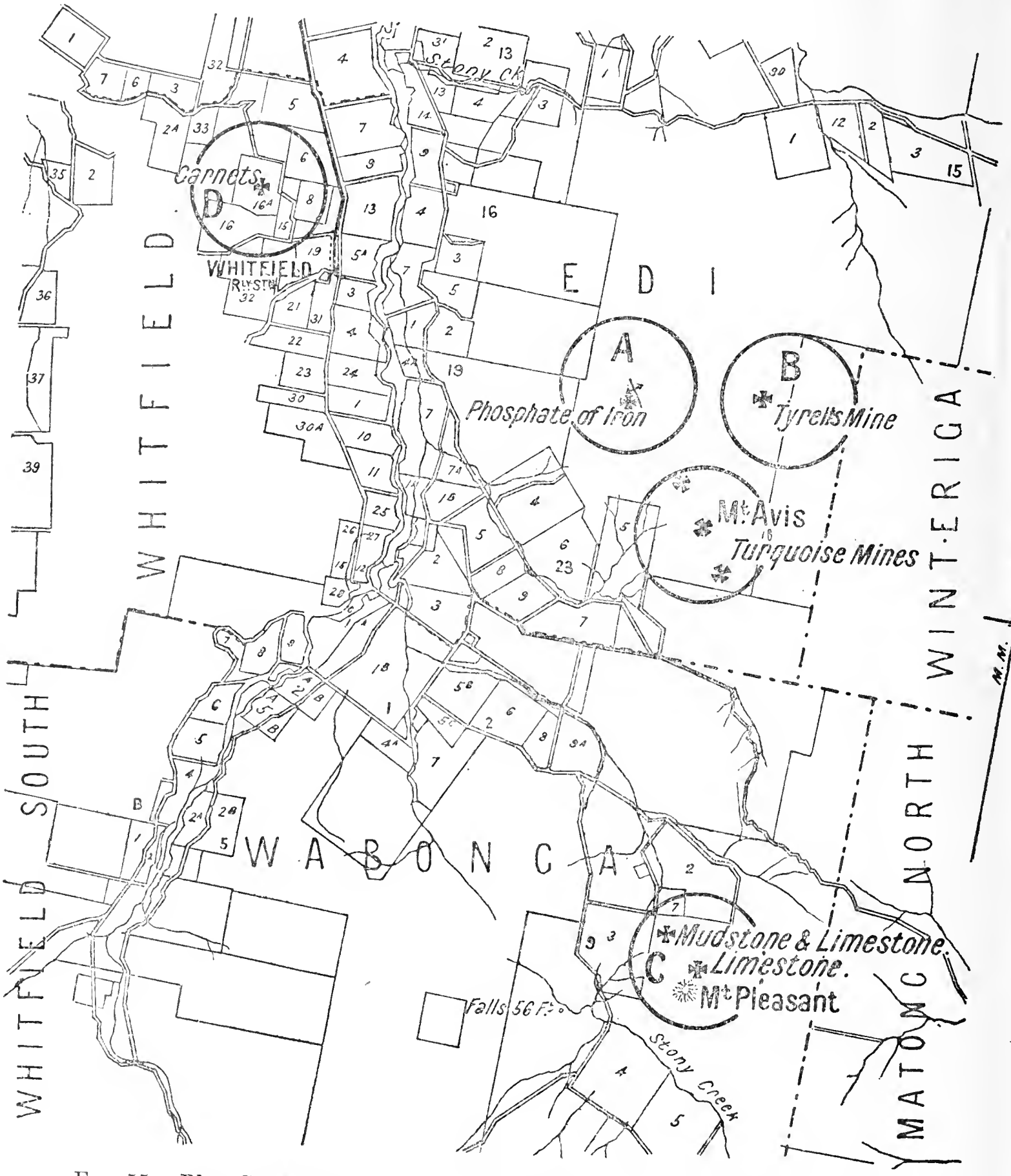


FIG. 55.—Plan Showing Localities of Mineral Deposits in the Whitfield District. (Scale—2 miles to 1 inch.)

The mudstones have been tested as to their suitability for terra-cotta tiles, and the result was favorable, but the beds are not conveniently situated or extensive enough for commercial working. Pigment tests were also carried out on samples of the mudstones, but proved unsatisfactory tests (Nos. 401 and 402). The appended analyses of the limestones show up to 15 per cent. of calcium carbonate, and a small percentage of phosphoric acid, and although the beds

are narrow and of no commercial value as limestones, yet the amount of weathering along Mt. Pleasant and its adjacent spurs must have added a quantity of lime to the soils, which have been washed down the King River valley.

It may be here mentioned that the King valley possesses three favorable and adjacent formations to account for the richness of its soils. On the east there are the small series of phosphate-bearing rocks of the Upper Ordovician formations, on the west the basalt tableland which has supplied a certain amount of lime to the soils, and on the south the Mt. Pleasant area already described.

Included in the analyses there is a sample of limonite collected by Mr. McKenzie, Inspector of Mines, from an extensive iron ore deposit on the Stoney Creek fall and below Tyrell's gold mine, in the Black Range. This limonite yielded a fairly high percentage of iron (assay No. 397). The softer sienna-coloured ore which accompanies the limonite might be used as a pigment body. A sample of gem sand was washed from the terrace drift on the western side of the King River valley, about 1 mile northerly from Whitfield township, and this contained a fairly large percentage of small fractured garnets of no commercial value.

The following are analyses and assays made at the Geological Survey laboratory by Mr. P. G. W. Bayly:—

(*A.*) *Phosphate Rocks, Black Range, Parish of Edi.*

Assay No.	Description.	Source of Sample.	Percentage of Phosphoric Acid.
			%
389 ..	Ferruginous slate ..	Main shaft, west of lode	1·63
390 ..	Slate formation (average)	Main shaft, west of No. 389	0·30
391 ..	Ore from small vein ..	Middle cut	8·24
392 ..	Richer ore from vein ..	Main shaft	21·57
393 ..	Slate (average) ..	Middle cut, east of No. 392	0·69
394 ..	Ore from vein	South cut	5·47
395 ..	Bedrock slate	¼-mile N. of workings ..	1·96
396 ..	Spotted ore	Middle cut	5·97
(See also Nos. 401–404).			

Assay No.	Description.	Locality.	Percentage of Fe_2O_3.
397	Limonite	Stoney Creek, Edi ..	71·0
398	Mudstone (2nd bed) ..	Mt. Pleasant, Wabonga	5·0
399	Mudstone (3rd bed) ..	Above Swinburne's, Mt. Pleasant	4·4
400	Dark green ore ..	Black Range, Edi ..	69·5

(*B.*) *Pigment Tests.*

Assay No.	Raw.	Calcined.	Remarks.
397	Colour, yellowish-brown, moderate covering power	Colour, chocolate-brown, moderate covering power	The covering power is low, considering the high iron content; the material is too dense to be regarded as sienna, but could be used as a pigment body
398	Colour, brown, poor covering power	Colour, reddish-brown, poor covering power	Insufficient covering power and colour for a pigment
399	Colour, brown, poor covering powe	Colour, light-red, poor covering power	Insufficient covering power and colour for a pigment
400	Colour green, moderate covering power	Colour, light-brown, moderate covering power	The green colour is not attractive or rich enough for a pigment; the calcined material has fair covering power

(*C.*) *Pottery Tests.*

Assay No.	Test O.	Test A. Muffle (1,100 degrees C.).	Test B. and C. (1,340 degrees C.).
398	Shrinkage 3 per cent., colour dull brown, firm brick	Shrinkage 5 per cent., colour light red, hard biscuit	Test pieces were completely vitrified and glazed
399	Shrinkage 3 per cent., colour dull brown, firm brick	Shrinkage 4 per cent., colour light red, hard biscuit	Test pieces were completely vitrified and glazed

The clays are non-plastic, but easily worked up. At a moderate temperature they turn to a fine terra-cotta tile, but at higher temperature are completely glazed and vitrified owing to the presence of fluxes. The materials are suitable for Marseilles roofing tiles and other pottery manufacture requiring low temperatures—as drainage pipes, &c.

(*D.*) *General Assays and Analyses.*

Assay No.	Description.	Locality.	Assays, &c.
401	Nodular limestone	Mt. Pleasant (top), Wabonga	$CaCO_3$ 15·0% P_2O_5 1·37%
402	Nodular limestone	Mt. Pleasant, first cliff south of Swinburne's	$CaCO_3$ 9·0% P_2O_5 0·31%
403	Limonite ...	Stoney Creek, Edi ...	Fe_2O_3 76·5% P_2O_5 2·82%
404	Limonite ...	Stoney Creek, Edi ...	Fe_2O_3 65·54% P_2O_5 2·45%
413	Phosphate ore ...	Black Range, Parish of Edi	See complete analysis
414	Gem stones ...	Whitfield	Determined as garnet

(*E.*). *Complete Analysis, No.* 413, *Phosphate Ore from Lode.*

Analysis—

P_2O_5	31·54%
Fe_2O_3	54·36%
FeO	4·86%
MnO	0·60%
MgO	0·22%
CaO	0·18%
H_2O + (110 degrees C.)	7·62%
H_2O −	0·38%
SiO_2	0·61%
Al_2O_3	nil
Cr_2O_3	nil
NiO	nil
CoO	nil
CuO	nil
As_2O_5	nil
SO_3	nil
TiO_2	nil
CO_2	trace
Total	100·37%

Formula (calculated to SiO_2 and H_2O − , free) = 14 Fe PO_4, $Fe_3P_2O_8$, $IOFe(OH)_3$.

Indicating dufrenite (basic phosphate of iron).

[22.9.13.]

THE INDIGO PIONEER MINE, INDIGO CREEK.

By J. P. L. Kenny, B.C.E., Assistant Field Geologist.

The Indigo Pioneer mine, on the west side of Indigo creek, is the result of a recent discovery of auriferous veins in granite made by Mr. George Archer, of Chiltern. Gold has been obtained for a distance of half-a-mile, and the south end of the auriferous strip of country proved so far is situated 4 chains S. 33° E. from the west corner of allotment 9M, parish of Wooragee North, county of Bogong. The strike of the auriferous strip of country is N. 42° W. The country rock is granite, and the gold occurs in small quartz and pegmatite veins, which strike N. 10° W. to N. 20° W., and dip from 40° to 50° west. Samples were taken at three points along the line, and assayed at the Geological Survey laboratory.

Fourteen chains to the south-east two veins have been opened up. The first vein is 12 in. wide. A sample (No. 706) assayed—

Gold	3 dwt. 22 gr. per ton.
Silver	7 dwt. 12 gr. per ton.

A sample (No. 707) was also taken of the decomposed granite and pegmatite adjacent to the vein, and assayed—

Gold	3 dwt. 6 gr. per ton.
Silver	2 dwt. 15 gr. per ton.

Thirty feet to the south-east another sample (No. 708) was taken from a depth of 4 ft., and assayed—

Gold	8 dwt. 19 gr. per ton.
Silver	1 dwt. 7 gr. per ton.

A sample (No. 704) from the country rock adjacent to the vein was also assayed and gave—

Gold	.. ..	Trace per ton.
Silver	.. ..	4 dwt. 14 gr. per ton.

On the north end two shafts have been sunk. The north shaft is 9 ft. deep on a 6-in. vein, which dips 50° west. The second shaft is 6 ft. deep on a 6-in. vein, which carried gold at the surface, but a sample taken from the bottom of the shaft gave no gold and silver.

Twenty chains to the south-east of these shafts another vein 18 in. wide has been opened to a depth of 3 ft. A sample (No. 705) taken from this vein assayed—

Gold	.. ..	3 dwt. 14 gr. per ton.
Silver	.. ..	2 dwt. 23 gr. per ton.

The veins improve in value going south-east and further prospecting in that direction may prove an extension of them. Where first opened up to the north they are just on the junction of the granite and the Ordovician beds, but to the south-east they pass into the granite.

All the samples were taken from oxidized veins. With depth the veins will become pyritic, and probably carry lower values.

[13.10.10.]

ARCHER'S WOLFRAM MINE, INDIGO CREEK.

By J. P. L. Kenny, B.C.E., Assistant Field Geologist.

Archer's Wolfram Mine is situated in the Indigo creek basin; its definite position being 15 chains E. 17° S. from the north-west corner of allotment 4, parish of Barnawartha South, county of Bogong.

The lode occurs in a schistose area of metamorphosed Ordovician rock. The schist is penetrated by a pegmatite (quartz, felspar, and muscovite) vein, which strikes N. 40° W., on the walls of which is the lode, consisting of quartz carrying auriferous arsenopyrite and wolfram. At the time of my visit two cuts 20 ft. apart had been opened up on the lode. The south cut showed the pegmatite vein 2 ft. with 8 in. of quartz, carrying wolfram, on the east wall and 15 in. of quartz with wolfram on the west wall.

Samples were taken and assayed by Mr. P. G. W. Bayly, at the Geological Survey laboratory. The 8-in. vein on the east wall assayed—

Sample No. 699—

Gold	.. ..	Trace per ton.
Silver	.. ..	1 dwt. 15 gr. per ton.
Tungstic acid (WO_3)		10.08 per cent.

A sample taken from the pegmatic vein gave a trace of gold and silver and tungstic acid nil.

A sample taken from the 15-in. vein on the west wall assayed—

Sample No. 701—

Gold	.. ..	Trace.
Silver	.. ..	Trace.
Tungstic acid	..	22.94 per cent.

From the second cut, 20 ft. to the north, a sample was taken from 12 in. of quartz with arsenopyrite on the west side of the lode, and assayed—

Sample No. 702—

Gold	.. ..	11 dwt. 18 gr. per ton.
Silver	.. ..	4 dwt. 14 gr. per ton.
Tungstic acid	..	Nil.

The samples were also tested for tin and copper. These metals were found to be absent. Samples Nos. 699 and 701 represent highly payable wolfram ore containing 13 and 30 per cent. of wolfram respectively. The value of the concentrates ranges from £80 to £100 per ton.

In sample No. 702 the gold is associated with arsenopyrite, no free gold is present, and the value of the ore has not been enhanced by surface enrichment. The mine is situated 7½ miles from the Government Battery at Chiltern, and the carting and crushing would be about 15s. per ton. Sufficient work has not yet been done to prove the extent of payable ore, but with further development there is every prospect of the mine developing into a payable proposition.

[13.12.10.]

THE CHILTERN GOLDEN BAR MINE.

By J. P. L. Kenny, B.C.E., Assistant Field Geologist.

The Chiltern Golden Bar lease is situated about 2 miles east of Chiltern township, and includes three main lines of reef, now known as the Golden Bar, the No. 1, and the No. 2. The Golden Bar reef was formerly known as West's reef, the No. 1 as Higgins', and the No. 2 as the Alfred or Alabama reef. In addition to these, a diagonal reef, known as the Alfred leaders, connects the No. 1 and No. 2 reefs. The main reefs run in approximately parallel lines, with a strike of N. 30° W., and usually dip within 10° of vertical. The reefs are intersected by slides which strike N. 40° W. and dip 45° west. Three of these slides have been met in a vertical depth of 730 ft., the position of the present bottom level. They are reversed faults, the hanging wall country having moved relatively in an upward direction, and the displacement is usually less than 50 ft. Only one cross-course occurs in the mine, about 400 ft. north of the shaft; the reef on the north side of the cross-course is heaved a few feet to the west.

A diorite dyke running nearly east and west intersects the reefs 250 ft. north of the shaft. The dyke has not had any influence upon the gold in the reefs.

The country rock consists of normal slate and sandstone, strike N. 30° W. The beds have a general dip to the west, often at a low angle. At the No. 3 level in the present company's shaft a remarkably flat bed of slate occurs. It dips to the west at such a low angle that it can be traced in the cross-cut for a distance of 70 ft. Minor synclinal and anticlinal folds occur to the west of the No. 1 reef, and probably a main syncline will be found further west.

Generally, the formations may be described as nearly vertical fissure reefs on the east side of a main syncline intersected by west dipping slides. The earlier workings on the reefs include open cuts, tunnels, vertical and underlay shafts, the workings extending in some cases to

a depth of 200 ft. Subsequently an engine shaft was sunk on the Golden Bar reef to a vertical depth of 100 ft.; at this point the reef was cut on a slide, and the shaft was continued on the underlay of the slide to a depth of 300 ft. The workings from this shaft are shown on the accompanying section of the Golden Bar reef. (Pl. X.)

The Chiltern Golden Bar Company commenced operations in 1901. A vertical shaft has been sunk to a depth of 802 ft. The Golden Bar reef has not, so far, been found payable below the workings from the old underlay shaft, and operations have mostly been confined to the No. 1 reef. Some particulars of the workings on the various reefs are given below.

Golden Bar or West's Reef.

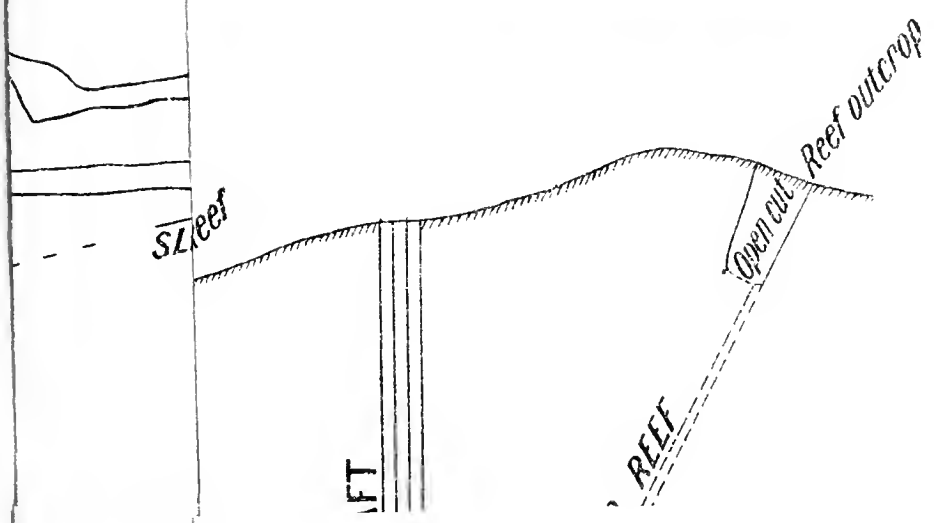
This reef, which is from 2 to 5 ft. wide, has been worked on the surface for a length of nearly 1,000 ft. It is reputed to have yielded about 20,000 tons of stone, averaging 1 oz. of gold per ton. In addition to the underlay shaft, the early workings on the reef included three open cuts, a tunnel, and two shafts to a depth of 150 ft., known as West's shaft and the South shaft. The Golden Bar reef strikes a slide dipping 45° west a few feet below the surface. It goes down on the slide to a depth of 200 ft., and then makes below the slide with an easterly underlay. Levels were driven from the underlay shaft at 64 ft., 120 ft., 220 ft., and 300 ft., the depths being measured on the underlay. Between the 180 and 220 ft. levels the reef was stoped for a length of 120 ft. It was 20 in. wide, and is said to have averaged nearly 1 oz. of gold per ton, giving a profit of over £5,000. In a winze known as Skerry's, in the 220-ft. level and 180 ft. south of the present company's shaft, a crushing of 25 tons yielded 18¾ oz. of gold, an average of 15 dwt. per ton, the reef being 2 ft. wide. Further south, payable stone is said to have been struck in driving north from the south shaft at depths of 50 and 130 ft. The 300-ft. level from the underlay shaft corresponds with the No. 1 level at 236 ft. from the present company's shaft. At the No. 2 level, 343 ft., a cross-cut was put out to the reef, a drive 280 ft. along it, and a rise connecting with the No. 1 level. The reef in the drive was found to be unpayable, a trial crushing averaging 3 dwt. Assays taken by Mr. H. Herman[1] indicate that the reef in the drive increases in value going south, the stone in the face being 2 ft. 3 in. wide and assaying 9.2 dwt. per ton. The reef here is worth a further trial, both by extending the drive south and by a rise from the present face.

At the No. 3 level, a cross-cut has been driven through the reef. A rise was put up 70 ft. from the shaft on a wall carrying very little stone. Fifteen feet east there is a body of slate and quartz 3 ft. wide; this is probably the Golden Bar lode. Mr. Herman's assay plan shows a value of 9.2 dwt. per ton here. This reef has not been tested.

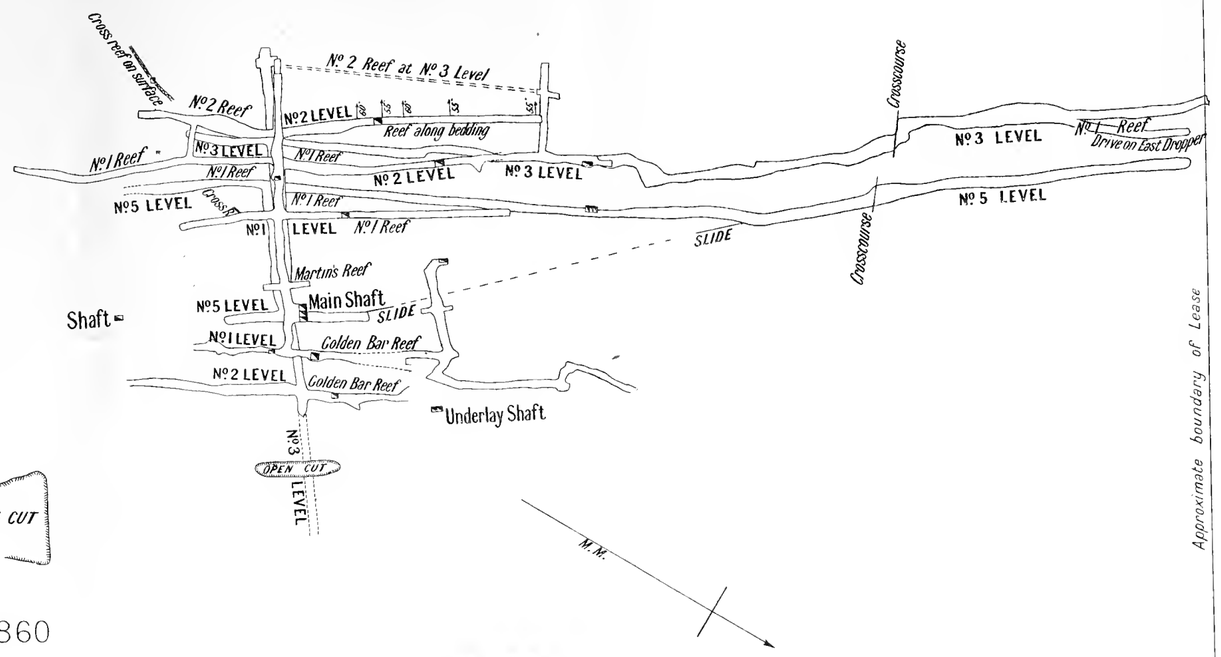
At the No. 5 level the Golden Bar reef was cut in the shaft. There are drives on the line north and south from the shaft for 50 and 60 ft. respectively. To the south the reef has been stoped for a length of 45 ft., and it is here cut off by a slide 20 ft. above the level. This slide was subsequently cut at the No. 6 level 110 ft. west of the shaft, and the throw proved to be 40 ft. A rise of about 40 ft. from the stopes over No. 5 level would intersect the reef above the slide, and possibly locate a payable shoot. According to Mr. Herman's assay plan, the stone just below the slide assayed 10.5 dwt. and 17 dwt., the reef being 12 in. and 19 in. wide respectively.

[1] When in private practice.

ERSE SECTION



GEOLOGICAL SURVEY OF VICTORIA
H. Herman, Director.
W. Dickson, Secretary for Mines.
The Hon. A. Bowmaker, M.L.A., Minister of Mines.

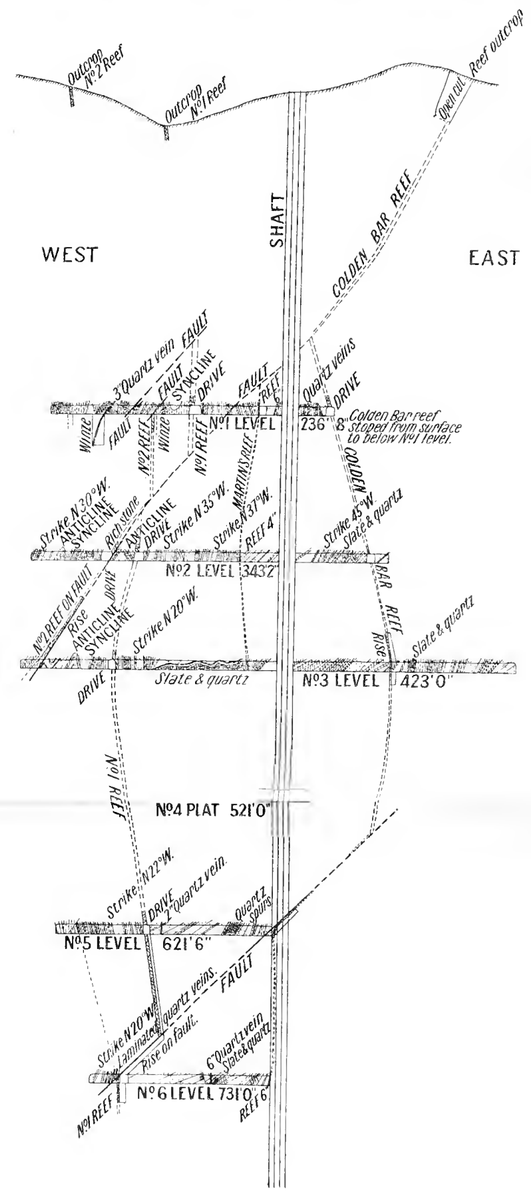


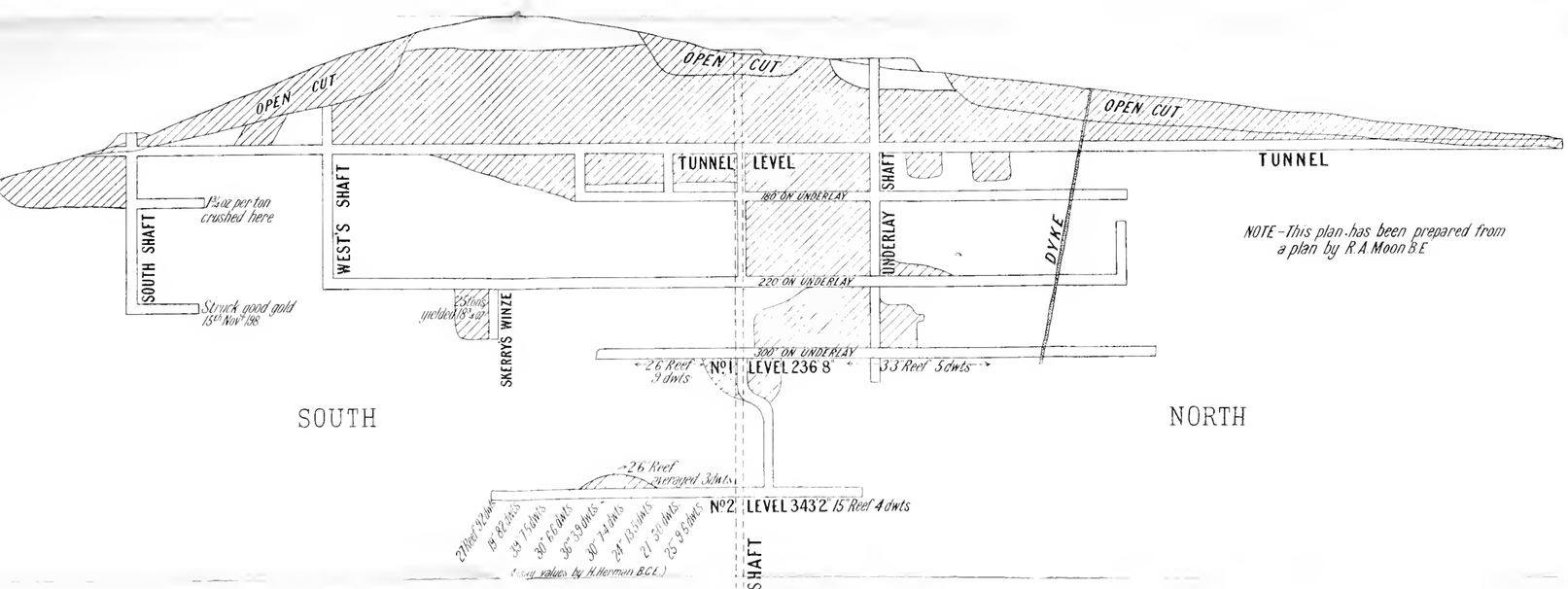
LEASE No 6860

PLAN

Approximate boundary of Lease

TRANSVERSE SECTION





NOTE - This plan has been prepared from a plan by R.A. Moon B.E.

LONGITUDINAL SECTION

(SHOWING STOPED OUT GROUND)

CHILTERN GOLDEN BAR MINE

CHILTERN.

Scale of Feet

0 100 200 300

J.R.B. Berry
24 9 11

From No. 5 to No. 6 level, a depth of 100 ft., the reef continued in the shaft. Good specimens are reported to have been obtained in sinking, but no driving has been done on the line. At the No. 6 level (731 ft.) the reef is 6 in. wide.

Martin's Reef.

This is a small laminated reef, about 8 in. wide, west of the Golden Bar reef. It is 15 ft. west of the shaft in the No. 1 cross-cut, 30 ft. west at No. 2, and 20 ft. west at No. 3. It does not show in the No. 5 cross-cut, but appears to turn flat to the west at the No. 3 level, and probably joins the No. 1 reef. At the No. 1 level there is a drive 35 ft. in length on this reef. At the No. 2 level it prospects about 15 dwt. per ton, but where intersected it is too small to be payable. The stone is laminated, and has a favorable appearance. If this reef increases in width it may carry a payable shoot.

The No. 1 or Higgins' Reef.

This reef, which outcrops 200 ft. west of the Golden Bar reef, has been the mainstay of the present company. On the surface it averages 2 ft. wide and dips 85° east. Two main shoots have been worked on the surface—one 100 ft. long, just south of the main shaft, and the other, about 150 ft. long, to the northern boundary of the lease. The first-mentioned shoot was worked to a depth of about 100 ft. from a whip shaft. The continuation of this shoot has been worked by the present company with payable results down to the No. 3 level at 423 ft., the shoot being 300 ft. long. Over the No. 1 level the reef was displaced by a slide pitching south; a similar slide displaced the reef over No. 2 level.

The continuation of the shoot worked on the surface to the north boundary of the lease has been worked over the No. 3 level for a length of 170 ft. with payable results. Seventy-five feet above the level the reef was cut off by a slide pitching north. This slide is probably the same as that near the cross-cut at No. 3 level, the pitch altering from north to south.

In the Golden Bar Extended Company's ground this slide was proved to displace the reef about 40 ft. The reef above the slide has not been tested by the Golden Bar Company. The shoot on the surface was 170 ft. long to the boundary of the lease, and is said to have been worked to a depth of 150 ft. This would leave a depth of 100 ft. from the old stopes to the slide. This portion of the reef should be tested by a rise from the No. 3 level. Below the No. 3 level at 423 ft. the No. 1 reef is poor. At No. 5 level (621 ft.) a drive goes north to the lease boundary. Two rises have been put up connecting these levels—one 220 ft. north of the shaft, and the other 100 ft. from the north boundary of the lease; these are now known as Chancellor's and the No. 2 winze respectively.

At the No. 5 level a slide pitching south was cut 400 ft. north of the shaft, and the drive from this point to the boundary is on this slide. In the face of the drive the slide appears to be pitching north. At the No. 6 level (731 ft.) this slide was cut in the west cross-cut at 110 ft. from the shaft. The No. 1 reef went underfoot below the slide,

and a rise of 40 ft. cut the reef above it. The rise was continued on the reef to the No. 5 level, the stone not being payable. At the No. 6 level the No. 1 reef has not been driven on. The reef would make below the slide if the drive were extended north, but as there is 40 ft. of blank ground on the slide, and also as a drive of 500 ft. is necessary to test the shoot near the north boundary of the lease, it would be advantageous to drive a new level at 800 ft., giving 180 ft. of backs below No. 5 level. The shaft at present is 802 ft. deep.

The No. 2 Reef.

The No. 2 reef is probably identical with the reef worked on the surface, and known as the Alfred or Alabama reef. It outcrops 60 ft. west of the No. 1 reef, and averages 1 ft. wide. The strike is N. 25° W., and the dip is east 85°. It has been extensively worked from the surface to a depth of 200 ft. by an open cut and a number of shafts. The No. 2 reef was first cut in the Golden Bar mine in the No. 2 cross-cut, 20 ft. west of the No. 1 reef. Here it carried rich stone, which was stoped for a length of 180 ft. and for a height of 75 ft. above the level. The reef is on the slide which carried the Golden Bar reef from the surface to 200 ft. It does not show at the No. 1 level. It is in faulted country, and appears to be cut off; but it will probably make again in settled country over the slide at 110 ft. west in the No. 1 cross-cut. Rich stone was got on the surface from this reef. A rise on the slide would probably cut the reef above it.

Between levels Nos. 2 and 3 the reef follows the slide. At the No. 3 level it is 50 feet west of the No. 1 reef. What is considered to be the line of the reef was cut in the No. 5 cross-cut 50 ft. west of the No. 1 reef. It carries no quartz. In the No. 6 cross-cut laminated auriferous quartz veins were cut at 110 ft., 40 ft. west of the No. 1 reef. This is considered to be the No. 2 line. It is possible that the reef is further west. It must leave the slide somewhere below the No. 3 level. A winze on the slide below this level, in addition to prospecting the reef, would locate this point and definitely fix the position of the reef in the levels below.

Alfred Leaders.

The reef known as the Alfred Leaders consists of two walls about 4 ft. apart, with quartz veins between. It extends diagonally from the No. 1 to the No. 2 reef, striking N. 20° E., and dipping 80° north-west. It is said to have been worked to a depth of 200 ft., yielding 15 dwt. to 3 oz. of gold per ton. At the No. 1 level the line was cut in the drive south on the No. 1 reef 25 ft. from the cross-cut. It carried 18-in. stone, but was not tested at this level.

Prospecting Work.

The prospecting work which has been suggested may be briefly recapitulated as follows:—

(1) A rise on the slide over No. 3 level, No. 1 reef.
(2) Rise and extend drive south, No. 2 level, Golden Bar reef.
(3) Rise on slide over No. 5 level, Golden Bar reef.
(4) Rise on slide at 110 ft., No. 1 cross-cut, No. 2 reef.
(5) Winze on No. 2 reef, below No. 3 cross-cut.

In addition to this work in the levels already opened up, sinking the main shaft will probably open up new bodies of payable stone. As the shaft is already down to 802 ft., a new level at 800 ft. could be driven without much sinking, giving 180 ft. of backs below the No. 5 level.

Yields.

The quarterly returns of the mining registrars give a total of 30,667 tons crushed for 9,507 oz. of gold from the Golden Bar and No. 1 reefs up to December, 1900, an average of 6.2 dwt. per ton. From the No. 2, or Alfred, reef, the records give a total of 1,842 tons crushed for 1,114 oz. of gold, an average of 12.1 dwt. per ton. These records are incomplete, the first, and probably best, crushings not being included. To the end of 1910 the Chiltern Golden Bar Company crushed 23,251 tons for a yield of 12,453 oz. 9 dwt., an average of 10.7 dwt. This gold has been won almost entirely from the No. 1 reef.

The mine is equipped with winding and crushing plant. The ore is free milling carrying gold, pyrite, and arsenopyrite. A new battery has been erected, but want of funds has delayed its completion. When finished it will permit of low-grade ore being mined at a profit, which cannot be worked at present.

[3.10.11.]

THE LADY ROSE MINE, CHILTERN.

By J. P. L. Kenny, B.C.E., Assistant Field Geologist.

The Lady Rose Mine lies to the north of the Golden Bar and Golden Bar Extended mines, and is working the same belt of auriferous country. Four lines of reef outcrop in the lease, namely, the No. 1 reef, the Cellar reef, the Lady Rose reef, and the Railway reef, in that order from east to west.

The No. 1 reef, which outcrops 210 ft. east of the Lady Rose shaft, carried good stone further south, furnishing most of the gold won by the Golden Bar and Golden Bar Extended companies. Just to the south of the Lady Rose lease boundary a shoot has been worked on this line from a shaft known as the Gift shaft, and said to be 180 ft. deep. A drive from the Golden Bar Extended Company's shaft was put out towards these workings, at the 400-ft. level, and intersected a slide dipping west. This slide would cut off the reef at a depth of about 350 ft. The reef above this depth and below the old workings has not been prospected. The slide has not been seen in the Lady Rose Mine, but it will probably be met with at a deeper level than the present workings. A cross-cut, now filled in, at the 93-ft. level in the Lady Rose Mine is said to be out 180 ft. east, and it probably cut the No. 1 reef.

The Cellar line outcrops about 75 ft. east of the Lady Rose shaft, and is the only reef so far worked in the mine. The reef dips 40° west, and has been worked down to the 316-ft. level. The quartz is irregularly distributed, but wherever met with is payable. At the present time a shoot over 90 ft. long, and averaging 14 in. wide, is being worked over the 255-ft. level. It will probably be found, as work proceeds, that the reef prospected so far is really following a slide, and that ultimately it will take a more nearly vertical course both above and below the slide. The shoot is pitching south, and will probably be found to be the continuation of the stone formerly worked on the surface on the Cellar reef, 200 ft. north of the shaft. In the bottom level, 316 ft., the reef showing in the drive is 6 in. to 5 ft. in width, and dips 40° west.

The Lady Rose reef outcrops to the north of the shaft. Two shafts have been sunk upon it—the Blue shaft, about 180 ft. deep, and the Ladderway shaft, 90 ft. deep. Some rich returns were obtained from these shafts by former parties. The reef is small and irregular. From the surface to a depth of 90 ft. it dips to the east, and below this point it dips to the west. The line is cut in the Lady Rose shaft at 93 ft., and cross-cuts 11 ft. and 27 ft. in length intersect it at 137 ft. and 172 ft. respectively. At the 255-ft. level a drive north-westerly along a small fault passed through a 2-in. vein carrying gold. This is probably the Lady Rose line.

The Railway reef outcrops 80 ft. west of the Lady Rose shaft. It has been worked on the surface to the north of the shaft, and the drive on the fault at 255 ft. is being extended to cut the line. This drive will cut the reef below the old workings, and payable stone may be expected here.

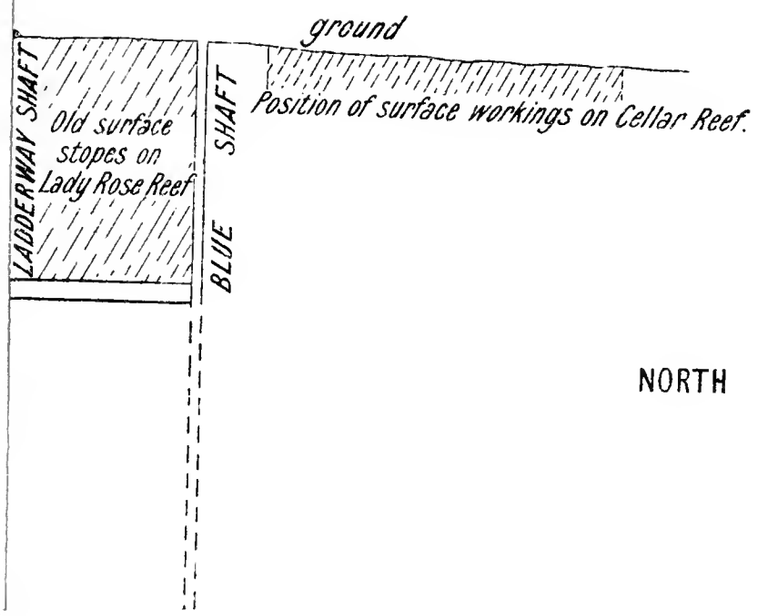
An interesting development in connexion with the mine is the occurrence of scheelite. The cross-cut west at the 316-ft. level passed through a 6-in. vein of quartz and calcite, dipping 40° west. Fifty feet to the south this vein junctions with the Cellar reef, and shows 5 ft. of quartz and calcite, carrying a high percentage of scheelite. Beyond this point irregular bunches of scheelite occur on the hanging wall of the reef, and the face of the drive 50 ft. south shows 18 in. of quartz and calcite, still carrying a little scheelite. Since the discovery at this level, the manager, Mr. Thomas Martin, has obtained a specimen of scheelite from mullock known to have come from the shaft at a depth of about 180 ft. This specimen probably came from the upward continuation of the same vein as indicated in the transverse section of the mine.

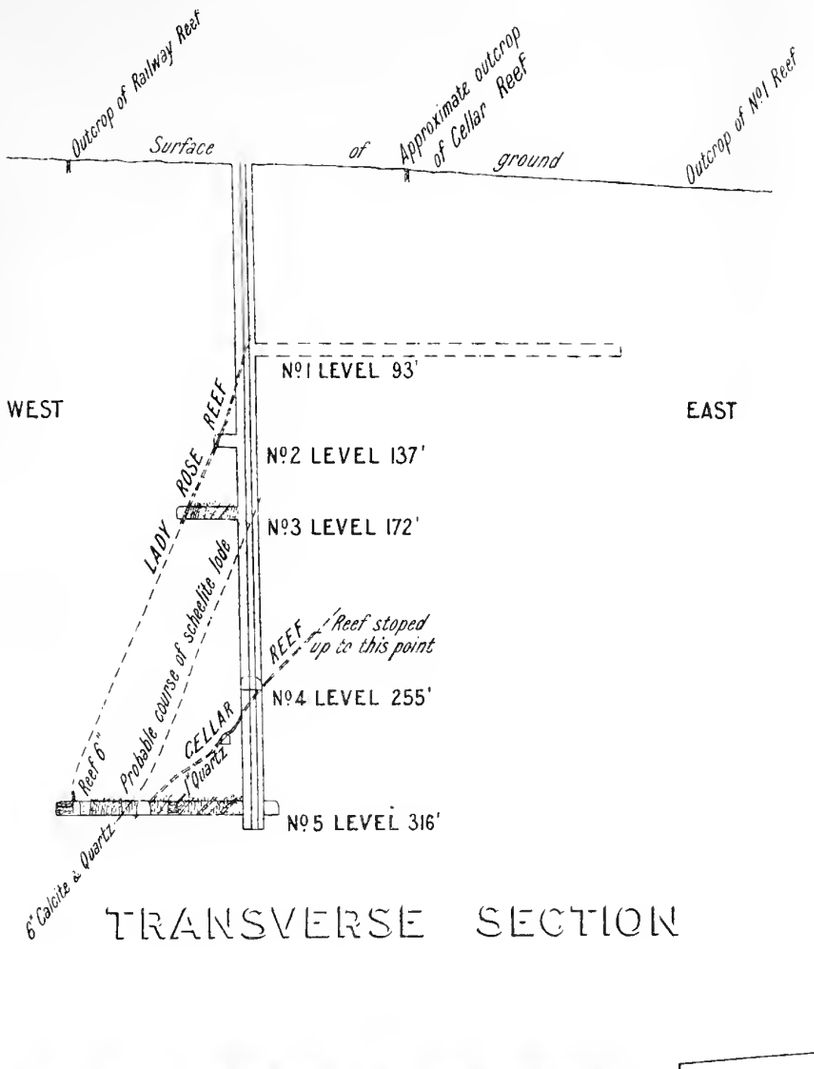
The mineral contains no impurities, and an assay made by Mr. Bayly, at the Geological Survey laboratory, gave 80 per cent. of tungstic acid.

The downward continuation of the shoot being worked over the 255-ft. level has been proved in an intermediate drive below that level, and, in order to work it, the 316-ft. level will be driven north. This level should also be extended south to test the reef in that direction. The stone has a tendency to occur in flat makes, showing the necessity of prospecting the reef by rises if it carries no stone in the drive.

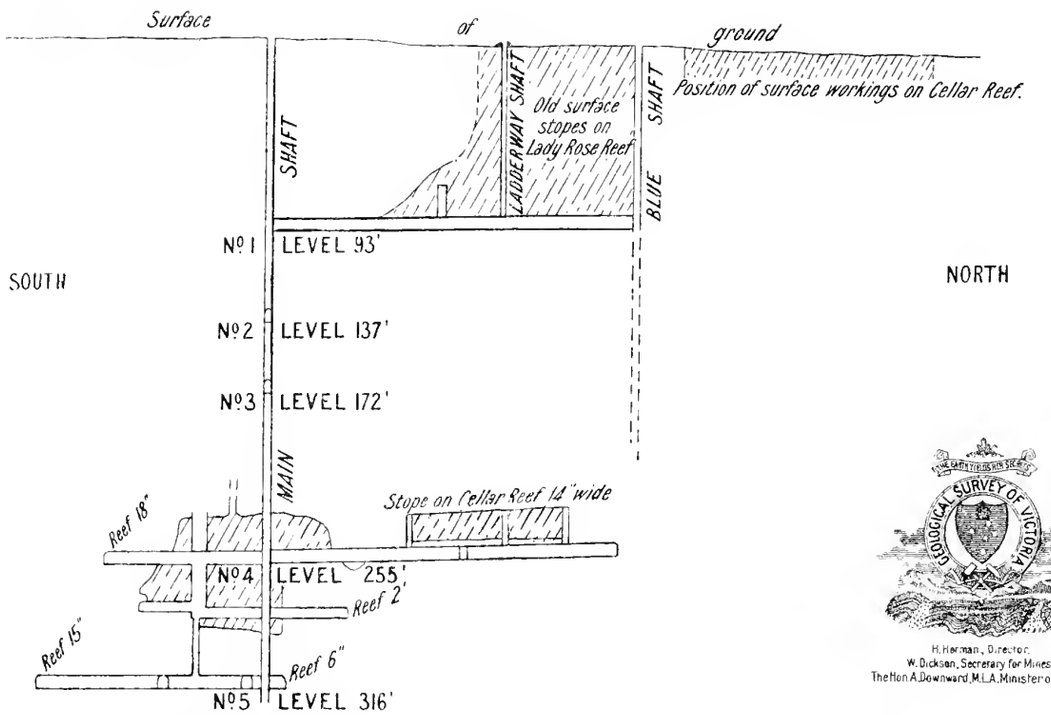
The prospects in the bottom level both for gold and scheelite justify further sinking before the upper levels are completely worked out.

Plate XI.


ground
LADDERWAY SHAFT
Old surface stopes on Lady Rose Reef
BLUE SHAFT
Position of surface workings on Cellar Reef.
NORTH



TRANSVERSE SECTION



LONGITUDINAL SECTION

H. Herman, Director.
W. Dickson, Secretary for Mines.
The Hon A. Downward, M.L.A. Minister of Mines.

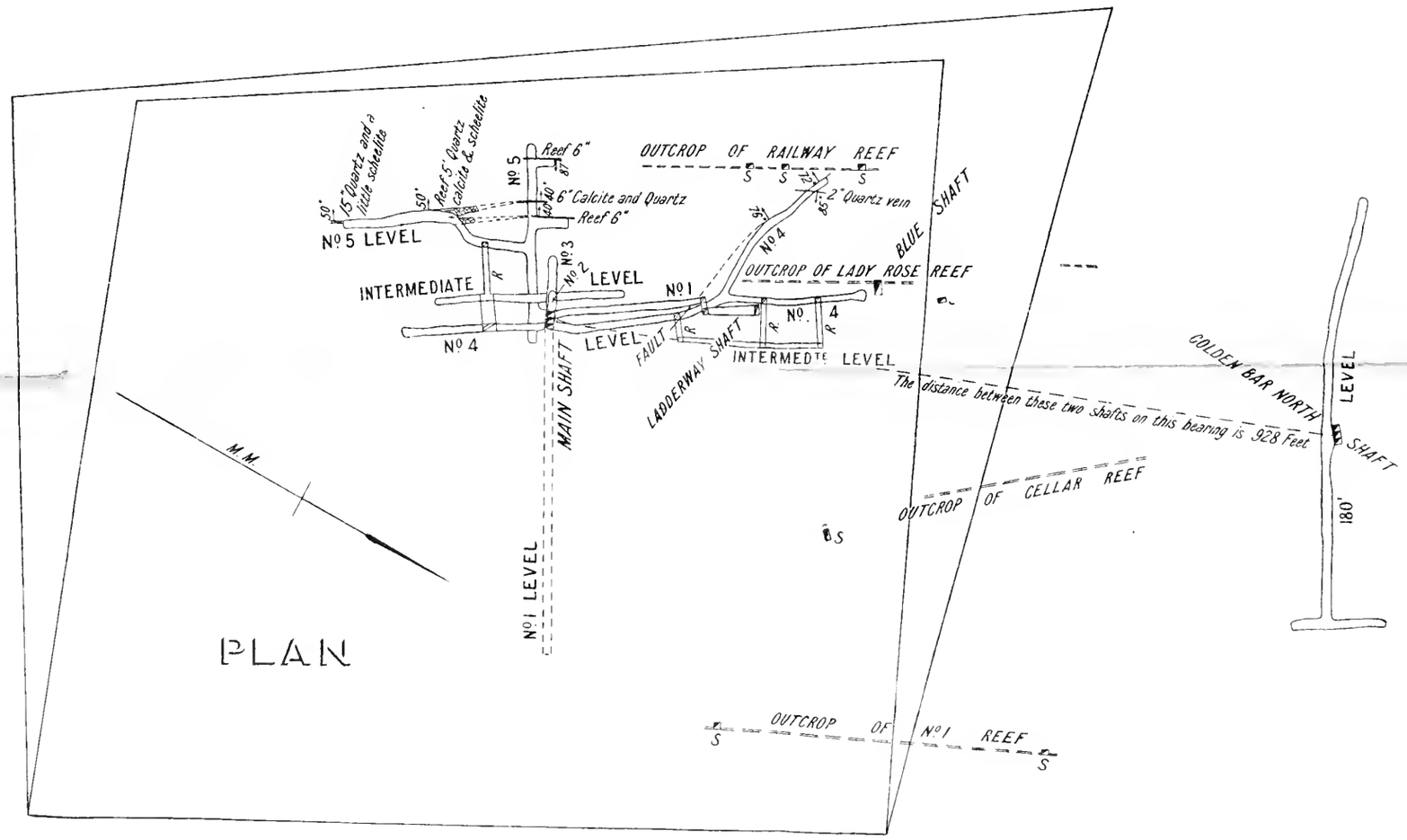
LADY ROSE MINE
CHILTERN

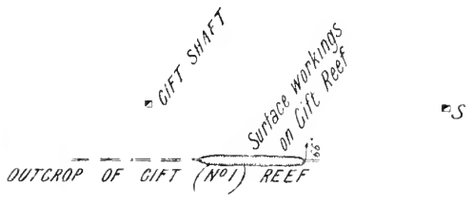
Scale of Feet

10 0 50 100 150 200

REFERENCE

Rises – R. Shafts – S.





Yields.

Lady Rose Reef.

The following crushings from the Blue shaft on the Lady Rose reef are taken from records in the possession of the manager:—

Ore Crushed.	Gold Yield.			
	Total.		Average per Ton.	
tons.	oz.	dwt.	oz.	dwt.
27	147	0	5	9
90	100	0	1	2
21	52	10	2	10
100	162	0	1	12
20	146	0	7	6
57	224	12	3	19
2	1	7	0	13·5
17	93	10	5	10
334	926	19	2	15·6
Sundry crushings	74	14	...	
Total ...	1,001	13	...	

In addition, 2 oz. 15 dwt. of gold and 62½ oz. of specimens are recorded from a dish and a half of surface dirt.

The Cellar Reef.

The following is the complete record of crushings obtained by the present company from the Cellar reef:—

Date.	Ore Crushed.	Gold Yield.			
		Total.		Average per Ton.	
	tons.	oz.	dwt.	oz.	dwt.
July, 1910 ..	33	19	12	0	11·9
Sept., 1910 ...	42	67	12	1	12·2
Jan., 1911 ...	19	15	14	0	16·5
Aug., 1911 ...	36	51	18	1	8·8
Dec., 1911 ...	38	49	18	1	6·3
Feb., 1912 ...	24	27	14	1	3·1
April, 1912 ...	40	77	14	1	18·8
July, 1912 ...	56	47	5	0	16·9
Total ...	288	357	7	1	4·8

From the 102 tons crushed from December, 1911, to April, 1912, 21 cwt. of concentrates were obtained, and gave a return of £40 18s. 3d.

The Golden Bar North Shaft.

This shaft is about 900 ft. north of the Lady Rose shaft. Work ceased here in 1909, and the following information is taken from the mine manager's reports:—Cross-cuts are driven east and west at 180 ft. A reef was cut in the east cross-cut at 92 ft. dipping 75° west.

A drive south was put in on the reef to 155 ft., and a rise up 42 ft. at the cross-cut. From the top of the rise a drive north 15 ft. showed 6 in. to 18 in. of stone, which was unpayable.

A winze was sunk 42 ft. on the reef, and drives put in 21 ft. north and 25 ft. south from the winze. The reef averaged 1 ft. wide, and dipped 75° west down to 12 ft., and then 60° east.

The east cross-cut was extended to 126 ft. from the reef.

Two crushings were put through, as given below, the first crushing being obtained from the winze:—

Ore Crushed.	Gold Yield.			
	Total.		Average per Ton.	
tons.	ozs.	dwts.	ozs.	dwts.
29	16	12	0	11·4
40	13	7	0	6·7
Total 69 ...	29	19	0	8·7

[6.9.12.]

ROYAL GEORGE TIN MINE, MITTA MITTA.

By J. P. L. Kenny, B.C.E., Assistant Field Geologist.

The Royal George Tin mine is situated at the head of Digger's Creek, about 5 miles north-west of Mitta Mitta township, the lode outcrop crossing a saddle on the spur between Digger's Creek and Scrubby Creek. The lode outcrop, which consists of the characteristic pegmatite of the district, can be traced for a distance of 450 ft. It strikes E. 28° S., and varies in width from 1 ft. to 15 ft. On the surface, the best values show on the west, and where the lode has been opened up for a length of 20 ft. It varies in width from 1½ ft. to 2 ft., and in places shows good ore. A few tons of stone have at some time been broken from an outcropping lens here, originally some 4 ft. wide, and the ore was apparently roasted on the spot. The present owners could give no information as to the result.

To the east of this cut, at a distance of 100 ft. along the line, two separate lodes outcrop. They are 25 ft. apart, and are each 2 ft. wide, a patch of good ore showing on the most northerly outcrop.

The lode crosses the spur 132 ft. from its most westerly outcrop, and here shows solid pegmatite 15 ft. wide, carrying a little tin. Just east of the spur this outcrop breaks up into three separate lodes, further east again only one lode shows, the width varying from 6 ft. to 8 ft.; 250 ft. east of the spur the lode is 8 ft. wide, and carries coarse tin and griesen. The lode has been traced for a distance of 300 ft. east of the spur; beyond this point it has not been traced.

The Royal George lode is in some respects typical of the lodes of the district. The lodes occur in lenticular masses, and consequently are very variable in width; the tin oxide is irregularly distributed through the lode, rich patches being separated by gangue, containing little or no tin. From my examination of the Royal George mine, I do not consider that the values of the ore in sight are sufficient to permit of the lode being worked on a big scale, while the patches of high grade ore are too small to give profitable returns, if worked alone. So far no work beyond surface cuts has been done on the lode and prospecting at a deeper level may reveal payable bodies of ore.

[22.12.14]

THE VICTORY MINE
GLEN WILLS

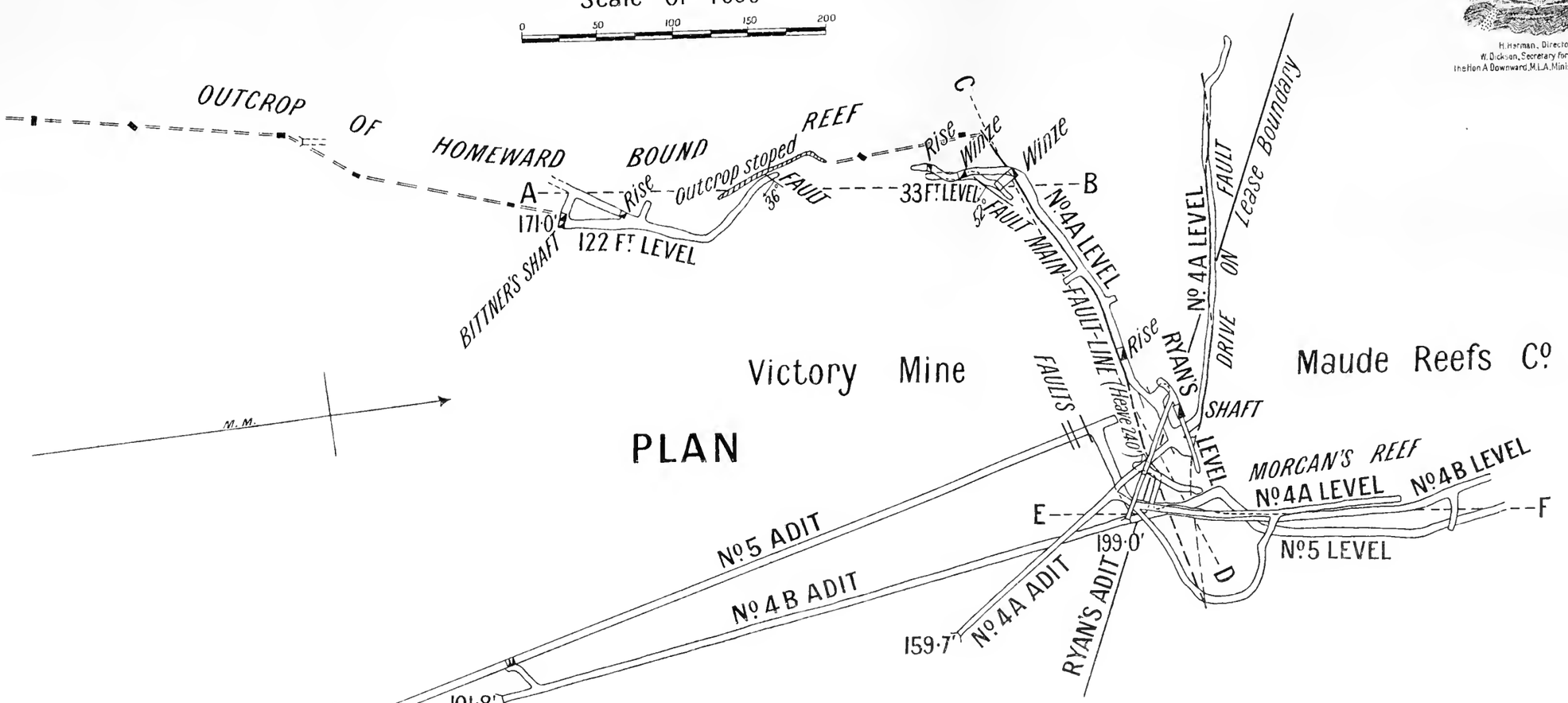
29 8.16.

Scale of Feet

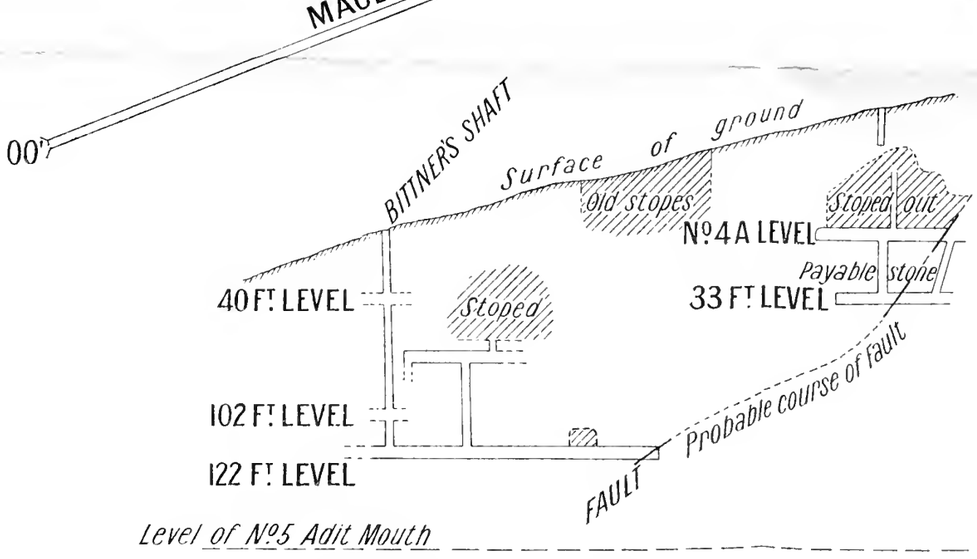
0 50 100 150 200

GEOLOGICAL SURVEY OF VICTORIA

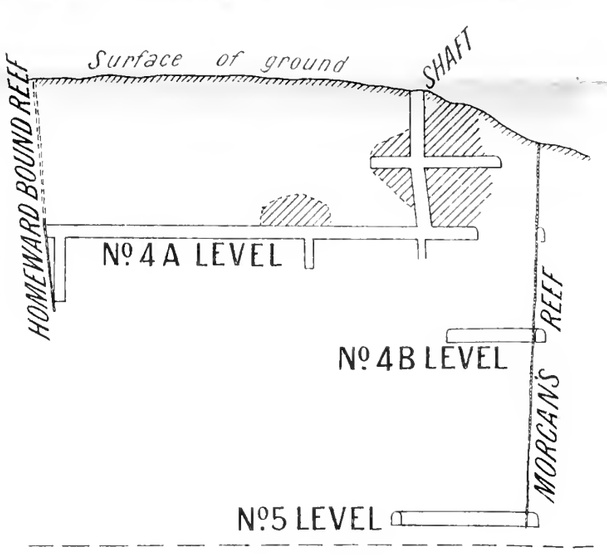
H. Herman, Director.
W. Dickson, Secretary for Mines.
The Hon A. Downward, M.L.A. Minister of Mines.



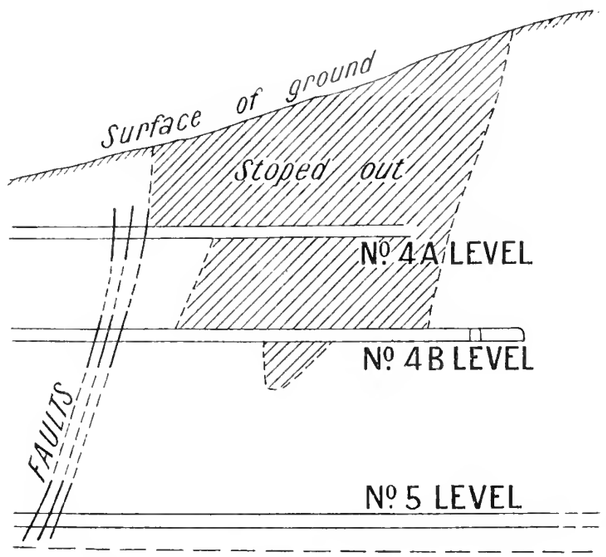
LONGITUDINAL SECTIONS



SECTION A-B HOMEWARD BOUND REEF.



SECTION C-D ON FAULT.



SECTION E-F MORCAN'S REEF.

TIN LODES AT DEAN'S CREEK, BOGONG.

By J. P. L. Kenny, B.C.E., Assistant Field Geologist.

Tin-bearing lodes near the head of Dean's Creek, in the parish of Bogong, found by me in what I believe is a new locality, being 6 miles south-east of the tin lodes at the head of Scrubby Creek. Six lodes carrying tin have been located, and on the principal lode surface specimens can be picked up for a distance of 3 chains; the lode where outcropping is 12 feet wide and carries good tin.

The locality is at an elevation of 3,000 feet above sea-level, but is easily accessible by a main spur from Granite Flat and is within a few chains of a permanent stream.

[1.4.13]

THE VICTORY MINE, GLEN WILLS.

By J. P. L. Kenny, B.C.E., Assistant Field Geologist.

The Victory mine, Glen Wills, owned by Messrs. Bittner and party, adjoins the Maude Reefs Company's lease on the south and includes the old Homeward Bound workings. To the north is Morgan's reef, a well-defined line included in the Maude Reefs Company's lease. It has been worked from the surface down to that company's No. 5 adit. To the south this reef is cut off by a zone of faulted country consisting of three separate fault lines, the heave in each case being right handed. On No. 1 fault the heave is 45 ft. to a block of stone, which was located and worked between the No. 1 and No. 2 faults. This stone is on the boundary line between the two claims. About 50 ft. to the west stone was cut by Bittner and party on the No. 3 fault, and 55 tons were crushed for an average yield of 1 oz. per ton. Since this crushing, Bittner and party have done a lot of prospecting in the fault zone of country without locating any payable stone.

To the south of Morgan's reef and the fault zone is the Homeward Bound line, which has been extensively worked to shallow depths. I am satisfied that this line is the continuation of Morgan's reef beyond the faults. Messrs. Bittner and party have of late been at work on this line. They have sunk a shaft to a depth of 122 ft., and connected with an old level.

They have driven on the reef to a point 160 ft. north of the shaft, where the reef is cut off by a fault. The reef in this drive is highly mineralized, and from 2 ft. to 3 ft. in width. The average assay value is 14 dwt. of gold to the ton. One small vein 3 in. wide assays 3 oz. 5 dwt. of gold and 421 oz. of silver to the ton.

The stone, on the whole, is not payable, and contains little free gold. Above this level the reef appears to have been worked from the surface to a depth of about 60 ft. Between the fault in the north face of the 122-ft. level there is a distance of 150 ft., in which the reef has not been located. I think there is a possibility of finding the reef, with payable stone, in this area.

To prospect the ground, the drive west on the No. 3 fault at the 4 adit level should be extended, on the south side of the fault, another

80 ft., if necessary. Should the work be successful in locating the reef, the prospects of it carrying payable stone are good, as the stone stoped on No. 3 fault was worth an ounce to the ton, and the reef, if located, may reasonably be expected to carry stone of similar value.

[20.4.15.]

IRON ORE AT NOWA NOWA AND MT. TARA.

By O. A. L. Whitelaw, Field Geologist.

In 1908 an inspection was made of the country surrounding Nowa Nowa and Mt. Tara, and the beds of that locality were searched for evidence to determine their age. In 1905, Mr. E. J. Dunn[1] submitted a report on the area, in which he stated that he considered the age of some of the beds were probably Heathcotian, and therefore among the oldest rocks occurring in Victoria. While it is possible that the cherty rocks, which lithologically resemble those of Heathcote, may be contemporaneous, there is no direct evidence that they are so. Palæontological evidence obtained by myself, and supplemented at a later period by Mr. W. H. Ferguson, definitely determines the age of the main series of sedimentary rocks abutting on the Snowy River porphyries as Upper Ordovician, a collection of graptolites obtained 5 miles 50 chains from Nowa Nowa, on the road cut by the Mines Department from Nowa Nowa to Buchan, containing the following:—

Didymograptus cf. caduceus, Salter.
Dichograptid fragments.
Dicranograptid fragments.
Diplograptus angustifolius, J. Hall.
Diplograptus, sp.
Diplograptids.
Climacograptus, sp.
Glossograptus hermani. T. S. Hall.
Glossograptus, sp.

Dr. T. S. Hall,[2] who identified these, states that their age is Upper Ordovician, although the exact horizon is uncertain; they are, however, lower than the Wellington River series and those of the Jordan-Thomson River. He considers that the relative abundance of *Glossograptus* is remarkable.

The most important outcrop of iron ore in this district is on the south-western slope of Mt. Nowa Nowa. (Fig. 56.) Nothing has been done in the way of development to show the dimensions of the ore occurrence except a small cut near the south-western end of the outcrop, where a solid body of ore of good quality some 8 ft. in thickness is exposed. Associated with this is siliceous and jaspidean material intersected with small veins and inclusions of iron oxide. The high-grade iron ore appears to occur in lenticles or shoots, the dimensions of which may only be satisfactorily determined by proper prospecting methods. The country is well adapted for tunnelling, and if a cross-cut tunnel were put in to intersect the ore channel at about 100 ft. or 150 ft. below the outcrop,

[1] E. J. Dunn, "The Iron Mask Ferro-Manganese Mine, near Buchan, East Gippsland," Rec. Geog. Surv. Vict., Vol. II., Pt. 1, p. 49.
[2] T. S. Hall, Reports on Graptolites, Rec. Geol. Surv. Vict., Vol. III, Pt. 2 p. 209.

it would determine its value and downward extension. Iron ore can be traced continuously in a north-westerly direction for a total length of 3,600 ft.

Several additional outcrops of iron ore, invariably associated with silica and jasper, and on the same general line of strike, outcrop between the south-westerly termination of the Mt. Nowa Nowa outcrop and Boggy Creek. At 6 miles 70 chains northwards from Mt. Nowa Nowa, along the tourists' road to Buchan, there is a well-defined outcrop about 100 ft. in width, consisting of micaceous iron, limonite, and haematite of good quality. The strike of this is W. 15° N.

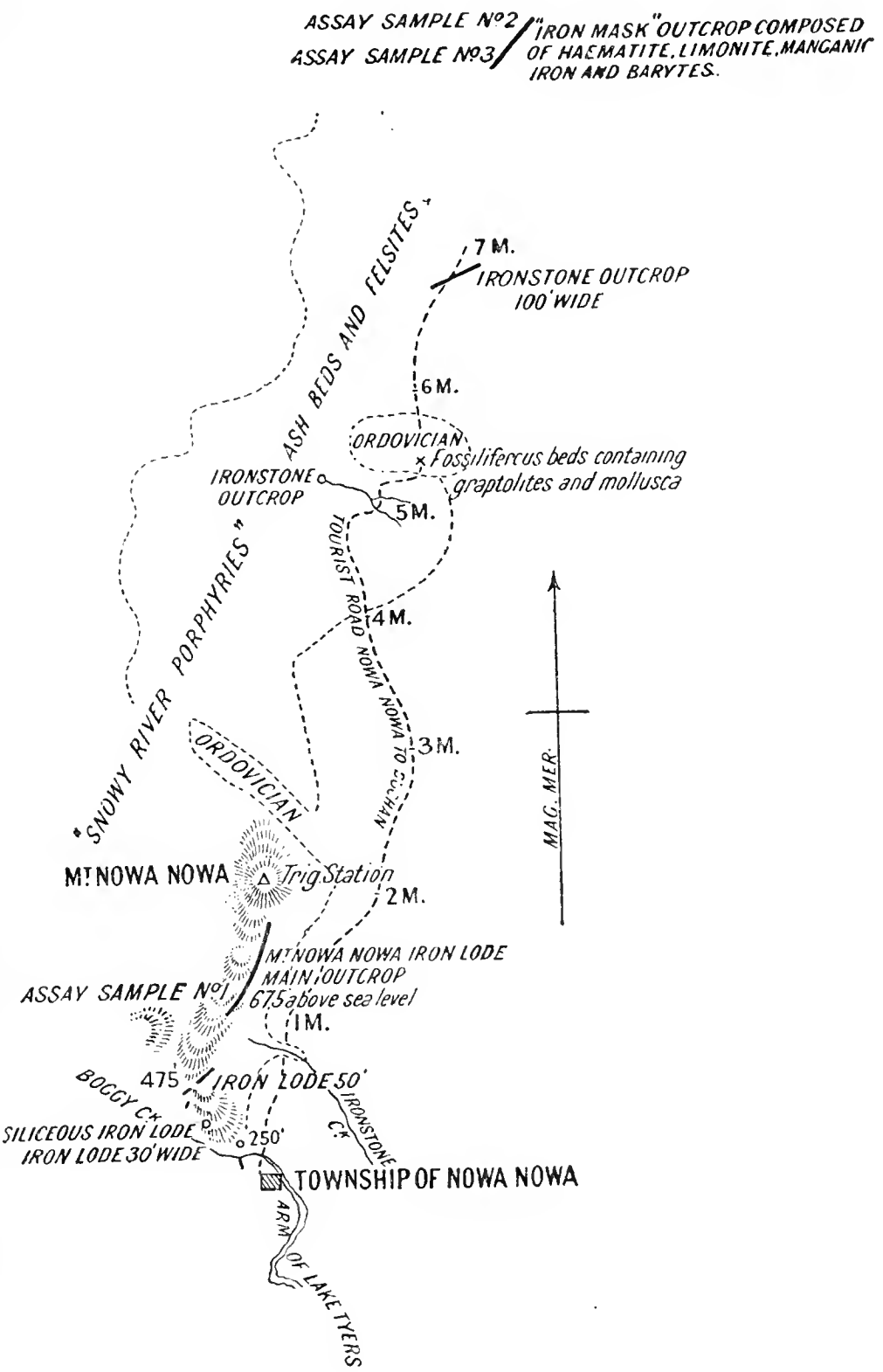


FIG. 56.—Locality Plan, showing Iron Ore Deposits, Nowa-Nowa.

(Scale—2 miles to 1 inch.)

The "Iron Mask" formation outcrops some $2\frac{1}{2}$ miles a little east of north of the last-mentioned locality, and has been the subject of reports by Messrs. Murray[1], Jenkins[2], and Dunn[3]. It consists of an outcrop extending along a length of about 1,000 ft., with an average width, projecting above the surface, of 30 ft. It is composed of haematite, limonite, manganese-iron ore, and manganese dioxide. Where visible the Lower Devonian ash beds for several hundreds of feet on either side of the main body are highly stained by iron and manganese oxides, and these are surrounded on the western side by an extension of the Tertiaries from the "Yellow-Water-Holes." The subangular and waterworn quartz pebbles and ash fragments of these drifts have been cemented into a conglomerate by the leaching of the iron. An outcrop of barytes occurs to the south.

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[1] R, A. F. Murray, "Report on Mount Tara," Prog. Rept. No. IX., Geol. Surv. Vict., 1907.
[2] Henry C. Jenkins, Spec. Rept., Dept. of Mines, 1901.
[3] E. J. Dunn, "The Iron Mask Ferro-Manganese Mine, near Buchan, East Gippsland," Rec. Geol. Surv. Vict., Vol. II,, Pt. 1., p. 49.

A shaft has been sunk to 50 ft. on the south-western end of the "Iron Mask" outcrop. Unfortunately, the upper portions of the shaft have been destroyed by bush fires, but it would appear from the dump that ore of a value equal to that at the outcrop has been obtained at the greatest depth reached. It is to be regretted that a shaft has not been put down below water level, and cross-cuts extended to prove the width and values of the ore bodies.

The most important geological feature in the Nowa Nowa and Mt. Tara belt is the occurrence of two belts of igneous rocks belonging to the Snowy River porphyry series, and including lavas and intrusive rocks. These are approximately parallel, with a strike of N. 10° E. to N. 20° E. (magnetic), and are separated by a belt of Lower Palæozoic sediments about 1 mile in width. The latter are, for the most part, considerably indurated. The occurrences of iron ore are confined to the porphyry, and it will be noticed by reference to the accompanying sketch plan that if a strike coincident with the general direction of the outcrop of the porphyry be projected from the Nowa Nowa outcrops, it will pass in close proximity to the outcrops extending to the "Iron Mask" lode. In all cases the iron is associated either with a silicification of the porphyries or the occurrence of siliceous or jaspidean veins in the porphyries.

The following are the results of samples submitted to the Geological Survey laboratory for assay:—

	No. 1 (334)	No. 2 (335)	No. 3 (336)
	Per cent.	Per cent.	Per cent.
Iron (Fe) ..	65.8	57.0	43.6
Phosphorus ..	0.013	0.034	0.028
Sulphur ..	0.025	0.074	0.109

The samples were also assayed for gold and silver. No. 2 sample contained 1 dwt. 7 gr. of silver.

No. 1. From large outcrop south of Mt. Nowa Nowa.
No. 2. North end of "Iron Mask" lode, Mt. Tara.
No. 3. South end of "Iron Mask" lode, Mt. Tara.

[20.4.14.]

GEOLOGY OF THE NOWA NOWA DISTRICT.

By W. H. Ferguson, Assistant Field Geologist.

Boggy Creek flows southwards and enters Lake Tyers a few chains below the Nowa Nowa bridge. The creek is rockbound for 3 or 4 miles from the lake; for some distance above the bridge, and below

until covered by the Tertiaries, the rocks in situ appear to be either Silurian or Upper Ordovician, more likely the latter. They consist of coarse, gritty sandstones, quartzites, and finer sandstones, with a considerable amount of mica, and iron pyrites in small veins. Other bands of greenish slates are acutely folded, and pitch steeply, in one instance, below the bridge, at an angle of 70° west. The last of the series appears about 9 chains above the bridge as slate, much crushed and folded.

Northwards along the Tara Range there are, in places, outcrops of Upper Ordovician rocks; these are well developed along the tourists' track to Buchan, and about 5 miles from Nowa Nowa a cutting has been made—Harris' cutting—where dark-blue mudstones were cut containing Upper Ordovician graptolites. A collection from these beds was previously made by Mr. O. A. L. Whitelaw, and determined by Dr. T. S. Hall.[1] Upper Ordovician rocks extend eastwards for over a mile from the cutting, and in a gully half-a-mile east graptolites were collected from crushed and broken slates, which sometimes assume the form of pale and black, much-shattered cherts. South-easterly from Buchan there are some prominent, rather sharp, peaks, composed in part of pale-blue to white slates and sandstones. From a spur which tends westwards from this portion of the range I obtained from decomposed slates graptolites apparently of Upper Ordovician age. From South Buchan the range tends north-east to the junction of Back Creek with the Snowy River; north of this junction Upper Ordovician graptolites were collected from pebbles of black slate in Butcher's Creek, Murrendal, and still further north in slates and cherty slates on the slopes of Mt. Deddick.

The rocks at Ironstone Creek, about 1 mile north-east of the Nowa Nowa Hotel, consist of slates, sandstones, and quartzites folded and much crushed, and striking about N. 30° E. They are Upper Ordovician or possibly Silurian, and are apparently portion of the Boggy Creek series. The beds below the bridge over Ironstone Creek are an extension of the supposed Ordovician sediments, and above it are bedded tuffs, &c., of which I made no personal observation.

A small exposure of peculiar, possibly Ordovician rocks, occurs at Monday and Stony Creeks, respectively 4 and 4½ miles from Nowa Nowa, on the Bruthen-road. They are almost horizontally bedded, and are highly metamorphosed, being micaceous and feebly crystalline. There are some members of the felsite series in the vicinity, either dykes or bands of porphyry.

It would appear that a belt of Upper Ordovician rocks occurs at the surface, as inliers, surrounded by the Snowy River porphyries, or Middle Devonian limestones. Various observers have referred to the fact that throughout Gippsland portions of the great porphyry series have been intruded through the Ordovician series.

Snowy River Fragmental Quartz Porphyry Series.

Nine chains above the Nowa Nowa bridge, along Boggy Creek, rocks, which probably belong to the Snowy River quartz-porphyry series,

[1] T. S. Hall, Reports on Graptolites, Rec. Geol. Surv. Vict., Vol. III., Pt. 2, p. 209.

extend for 3 or 4 miles. The first rocks noted appear to be tuffs made up largely of small fragments of slate; higher up the creek these rocks are succeeded by tuffs, porphyries, and felsites. On the east bank of the stream, however, about three-quarters of a mile above the bridge, there is an inlier of decomposed pale-yellow rocks, either decomposed slate or fine tuff of the porphyry-felsite series, in which a slaty structure has been developed. They show some obscure markings, preserved as a thin silvery greenish streak, which may have been caused by vegetable remains.

Iron Ore, Limestone, Barytes, and Other Minerals.

Micaceous iron ore occurs very freely in the porphyry-felsite, and very sparingly in the Ordovician series. I did not visit all the outcrops in the district, but along the tourists' track to Buchan there are some of high-grade iron ore a chain or more in width. Throughout the porphyry-felsite series barytes and red jasper occur irregularly, the latter sometimes plentifully. Manganic iron ores occur at the Iron Mask mine, and at other places along the Tara Range, south-east of Buchan; fine-grained rocks have been so saturated with iron-bearing solutions that they now constitute a fair grade iron ore; from a surface inspection, it is not possible to say whether these fine-grained rocks are altered members of the felsite or Upper Ordovician series.

About 3 miles east of the Buchan accommodation house, on the Bruthen-road, at Canni Creek, I noticed micaceous iron ore in rocks belonging to the porphyry-felsite series. An outcrop of Middle Devonian limestone, the nearest to the Bruthen-Orbost railway, occurs at the accommodation house. The white mica and quartz veins carrying pyrites, so noticeable in the Ordovician rocks, seem to be absent from the porphyry-felsite series.

I was asked to inspect a silver lode below the Ironstone Creek bridge. A quartz reef, about 3 ft. thick, occurs in hard slate and sandstone; it is in centre country, pitches underfoot to the north, and is heavily mineralized for two-thirds of its width with iron pyrites, and to a lesser extent with arsenical pyrites. A portion of the reef decomposed to a gossany quartz is said to contain some very fine gold.

In the bed of the stream a hole has been sunk for a few feet, but the exposure is very limited. A ton of quartz is said to have been treated as a bulk assay, and yielded 80 oz. of silver and 13 dwt. of gold per ton; but samples collected by me, and assayed at the Geological Survey laboratory, gave very poor results, and indicated that the reef was not payable.

Summary.

In the Nowa Nowa district there are, omitting the Tertiaries, three predominant series—the Upper Ordovician, the felsite-porphyry series, and the Middle Devonian marine limestones.

The Upper Ordovician sandstone near Nowa Nowa contains a considerable quantity of mica and irregular quartz veins, intersected with veins of iron pyrites. Near Boggy Creek bridge this series is folded, and pitches steeply, dips up to 70° being observable.

The slates and mudstones along the Tara Range are fossiliferous, yielding in places Upper Ordovician graptolites, and in other places passing into cherts not unlike those at Longwood, Heathcote, and elsewhere in Victoria.

The porphyry-felsite series is well developed around Buchan, and passes up by passage beds of varying thickness at the Murrendal River into Middle Devonian limestones.

To the west of Mackinson's, South Buchan, and W. Tree, Mt. Murrendal, the porphyry-tuff series contains the remains of plants; no detailed work has been done on these, but they are considered to be Lower Devonian.

Presumably there is a physical unconformity between the sandstones, &c., at Boggy Creek and the porphyry-felsite series higher up the creek. There was no evidence of the porphyry-felsite being folded with the sedimentary series.

The white mica and quartz veins usually present in the Ordovician are generally absent from the quartz porphyry series.

Some deposits of iron ore, limestone, barytes, and other minerals have been noted, with remarks on their origin and occurrence.

[5.3.13.]

RECENT MINING IN CROAJINGOLONG.

By H. Herman, M.M.E., &c., Director of Geological Survey.

Immediately prior to and during Easter I inspected some of the more recent developments in mining east of the Bemm River. I first visited the Hard-to-Seek gold-field, situated about 3 miles east-south-easterly from the Wingan River crossing of the Orbost to Genoa main road. Here two quartz reefs (Brown's and Duffy's), in granite, have been prospected since the beginning of the year. The workings are on a ridge rising in one part to a height of about 1,200 ft. above sea level. Brown's reef (James Brown) is quartz, with hematite, strikes N. 75° E., dips 80° to the northward, and has been sunk on nearly 20 ft. deep. The lode is 6 in. to 9 in. thick near the surface, and about 12 in. in the bottom, for the full 8 ft. length of the shaft; numerous red and brown clay veins cut through it. The walls are decomposed coarse-grained granite. Three tons of picked stuff carted to and crushed at Yambulla, New South Wales, about 40 miles distant, returned, Mr. Brown informed me, about 11 oz. of gold; the return showing the quality of the gold had not been obtained.

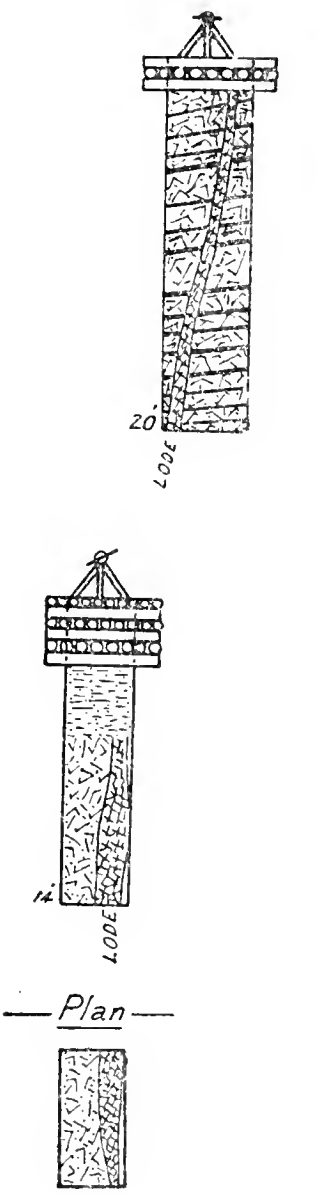

FIG. 57.—Sections of Shafts, Duffy's Reef.
(Scale—20 feet to 1 inch.)

From the surface downwards patches of iron pyrites occur in the gossan and quartz. The claim is registered as a prospecting area of about 300 yards square.

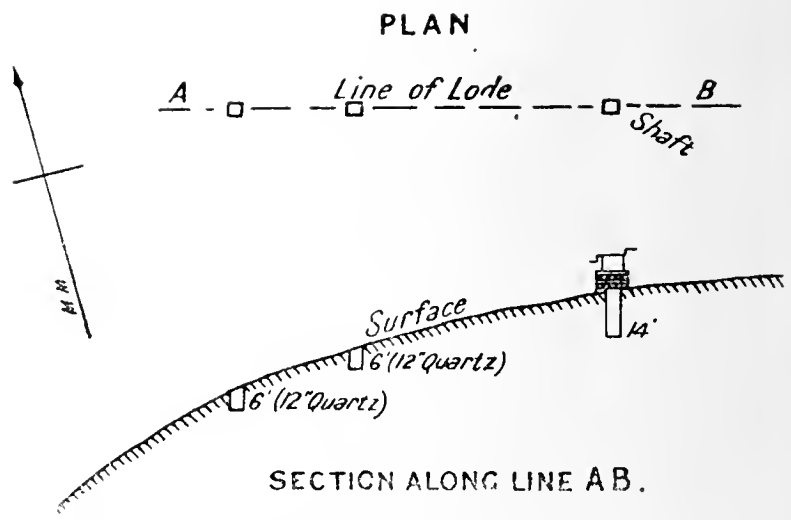

FIG. 58.—Duffy's Reef, Plan and Section.

(Scale—Approximately 160 feet to 1 inch.)

Duffy's reef (John Duffy) is about half-a-mile southerly along the ridge from Brown's. A shaft is about 14 ft. deep; the lode in the west end is as in Fig. 57 in decomposed granite. In the east end of the shaft the lode is smaller, and not so well defined. A plan of the bottom of the shaft is as in Fig. 57. The lode is nearly vertical as far as sunk on; the west face is solid quartz, with a little iron pyrites, copper pyrites, and galena. The strike is N. 75° to 80° E. The apparent continuation of the line of lode westerly has been cut in holes about 1 and 2 chains distant respectively from the shaft shown in Fig. 58. A little gold was visible in the stone broken from the shaft; a trial crushing is necessary to ascertain its value. Fig. 59 shows, roughly, the topography of the ridge and the relative positions of the two reefs.

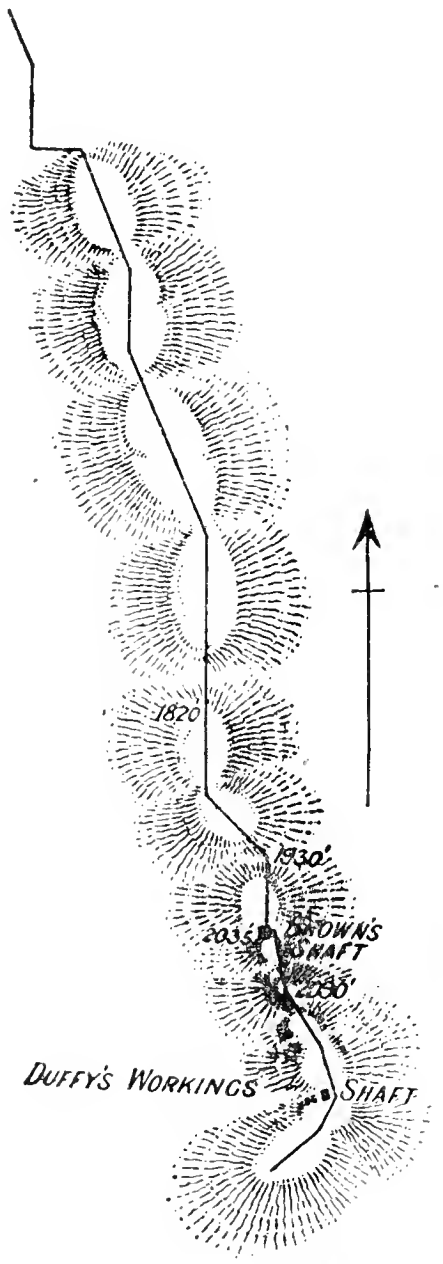

FIG. 59.—Plan of Ridge, showing Duffy's Workings.

(Scale—1 mile to 1 inch.)

A few additional prospectors, who had not found anything of apparent value, were at work in the locality at the time of my visit. The field hardly warrants the attention of more than a few men until more work has been done on the lodes already found.

Molybdenite Workings at Wangrabelle.

Molybdenite lodes are being worked near Wangrabelle township, in allotment 19, parish of Wangrabelle. A prospecting party, of which Mr. Henry Allan and William Bridle are principals, started sinking here in June, 1911. A shaft is down about 70 ft., and a level opened at 50 ft. deep for 5 ft. easterly and 45 ft. westerly. The lode in the level strikes south 78° west, dips 75° northerly, is 12 in. to 15 in. thick in the east face, and 12 in. in the west face. For the full length of 50 ft. the lode, which is of solid quartz, shows strong and unbroken in the level, and gives the impression that it may prove to be of considerable extent, both longitudinally and vertically. Molybdenite, iron pyrites, white mica, and molybdic ochre occur freely in the lode. The molybdenite is in laminations and patches in the lode, and in specks and joint faces of the adjoining granite. Mr. Bridle says that in the bottom of the shaft (not accessible owing to water) the lode is 18 in. wide, showing molybdenite freely; and that in the shaft, from the surface to 50 ft. deep, the average is about 10 in. As far as the lode has been exposed, it has on the footwall side a band of greenish-grey igneous rock about 12 in. wide, which may be an alteration product of the granite or a dyke. This rock carries small quartz veins, and molybdenite on faces and in specks.

About 15 chains south-easterly from the shaft described a second shaft (No. 2 on plan) is down 14 ft. on another quartz-molybdenite vein. This shaft is about 6 chains west of the boundary, between allotments 19 and 21. Surface soil and broken reef show to 7 ft. deep, then a solid quartz lode, 18 in. to 2 ft. wide to the bottom. Splashes of molybdenite in the solid quartz start to show at 12 ft. or 13 ft. deep; odd colours only are visible above. The strike is nearly east and west, dip 65° to 70° to the north.

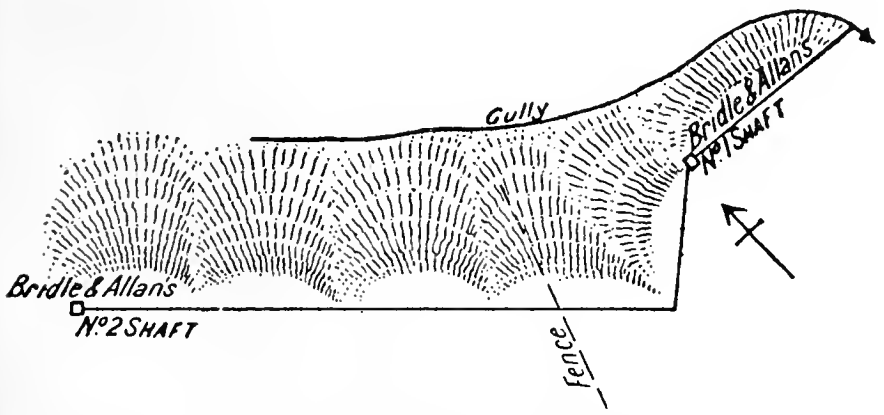

Fig. 60.—Bridle and Allan's Workings, Wangrabelle. Scale, 8 chains to 1 inch.

Several outcrops of apparently similar lodes occur within a radius of 10 chains of Bridle's workings. The prospectors of the district knap the outcropping quartz and examine it for traces of molybdenite, but do not expect to see the mineral freely until a depth of 20 ft. or 30 ft. is reached. Specimens of stone, from the surface and 50 ft. deep of the country rock and the footwall band of altered rock or dyke, are now in the Geological Survey museum. A parcel of about one ton of picked ore sent from No. 1 shaft to Melbourne assayed 7 per cent. molybdenum.

Unusual interest surrounds molybdenum mining at the present time in view of the recent phenomenal rise in the price of the metal shown as follows:—

Year.	Principal Buyers.	Per Ton.	% Mo S_2 (Molybdenite.)
		£	
1909	American	90	—
1911	,,	136	90
1911	,,	133	95
1913 (Oct.)	French	260	—
1913 (Dec.)	,,	326	—
1914 (Jan.)	,,	462	94
1914 (April)	,,	560	—

The present price in Australia is about £500 for 90 per cent. sulphide. Ore should contain 80 per cent. of molybdenite, below which the price per unit is lowered, and be as free as possible from copper, arsenic, bismuth, and tungsten, the presence of which reduces the commercial value. The market is sensitive, and a sudden large increase in production would be likely to cause a large drop in prices. Molybdenum and its varied compounds are utilized for dyeing and pigmentation; but its principal use has been for hardening and toughening steel for such purposes as propeller shafts, heavy cranks, guns, boilers, shells, and tool steel. The present heavy demand is stated to be due to the discovery in France of some new, but unrevealed, process, in which molybdenum is necessary, to prevent the deterioration of cordite, the assigned cause of more than one catastrophe to large battleships.

In Queensland and New South Wales molybdenite occurs in many places so coarse that it is practicable to obtain a marketable product by hand-breaking and picking. For finer-grained ore it is necessary to crush and extract the material in some other way. Ordinary concentration presents difficulties because of the extensive sliming that arises from even fairly fine crushing and the loss of mineral in the tails; but the now common flotation method of separating metallic sulphides appears from actual work done to effect a good recovery at no great cost in plant nor heavy running expenses. Allan and Bridle's lode in the No. 1 shaft certainly looks promising enough to persevere with, and Sydney people have taken an option over it. If a few more similar lodes should be opened up, it might be worth while going into the question of erecting a small flotation plant on the field as part of the policy of erecting State batteries.

Molybdenite and other molybdenum compounds have been found also in small quantity—not, so far, of any commercial value—at Mt. Moliagul, Maldon, Mt. William, Kitchington Creek, Yea, Neerim, and other places in the State.

Graphite near Murrungowar.

About 3 miles north-westerly from the hotel at Bell-Bird Creek, on the main Orbost to Genoa road, in allotment 43, parish of Purgagoolah, between Cabbage Tree Creek and the old Marlo to Bonang mining track, Mr. John Close has quite recently found graphite. A few cuts on either side of Sundown Creek, an eastern tributary of Cabbage Tree Creek, show Ordovician crumpled slate and sandstone, with quartz

veins to carry graphite on faces and joints for a width of about 15 ft. Iron pyrites is also freely seen. Mr. Close has a 5-acre prospecting claim, and has applied for a 30-acre lease.

The graphite occurs in very small percentage of the whole, and the deposit gives little promise of becoming of commercial value.

Some mining is in progress at some of the older fields in Croajingolong. These I did not visit. Between Bendoc and Clarkville I understand that a Bombala company is sinking a shaft to 200 ft. deep on the New North Discovery lode, worked by a Ballarat company many years ago; and that, about 10 chains distant, the old Victoria shaft is being baled out by other owners for the resumption of mining operations. A small battery is crushing also at Combienbar.

[4.5.14.]

SILURIAN SILICIFIED CORALS AND A POLYZOAN FROM RUSHWORTH.

By Frederick Chapman, A.L.S., F.R.M.S., Palæontologist to the National Museum, Melbourne; Hon. Pal. Geol. Surv., Victoria.

Introduction.

The following report is based on a collection of 35 specimens of corals and a polyzoan, altered by silicification, which were obtained by Mr. A. M. Howitt in September, 1914. They are of especial scientific interest, on account of the proof they afford of the occurrence of undoubted Yeringian beds at Rushworth.

Rushworth lies in a north-easterly direction from Heathcote, and is about 28 miles distant. At the latter locality palæontological evidence shows the sandstone to contain a small fauna comparable elsewhere with the Melbournian; and therefore these two localities, Rushworth and Heathcote, are probably on different lines of strike. The North Waranga mining division, including Rushworth, has been subjected to a peculiar tectonic disturbance, which has thrown the folds of Silurian strata almost at right angles to the normal strike of the beds to the north and south of that area.[1] This disturbance has evidently caused the extreme alteration of the strata at Rushworth and the neighbouring localities, inducing the silicification and auriferous conditions, particularly of the limestone beds.

This collection, consisting entirely of corals, points to the existence of a more or less clear water or limestone phase of the Yeringian sea at Rushworth, although some other fossils, previously recorded, show an intermingling of conditions. This locality appears to cover the most northerly point of the westward margin of the Yeringian basin, where to the south one meets with it again on approximately the same line of strike at Merriang and Glenburnie-road, Whittlesea; but where, however, the fauna was developed in the direction of an argillaceous or mudstone phase, containing trilobites and brachiopods, as described by Mr. Jutson and myself.[2] Mr. Howitt has shown me, in addition to the present collection, an extensive series of large crinoid stem joints, collected mainly from intervening argillaceous or mudstone beds in the vicinity.

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[1] Prog. Rep. No. V., Geol. Surv. Vict., 1878, p. 154.
[2] Proc. Roy. Soc. Vict., Vol. XXI. (N.S.), Pt. I. 1908, pp. 211–225.

Previous Determinations of Rushworth Fossils.

In the Progress Report of the Geological Survey of Victoria,[1] Sir F. McCoy gave a description of some fossils from Whroo, near Rushworth, in his "Schedule of Reports on Fossil Specimens," in which he says, "Almost indeterminable casts in sandstone; of these there are two articular surfaces of crinoid stems of the *Actinocrinus* type, one small coral, probably *Favosites fibrosa*, one indeterminable lamellibranch and two fragments of the Upper Silurian variety of *Orthis calligramma*. In regard to the age of the beds, as determined by McCoy, that author stated that "The balance of the evidence is in favour of the rock being Upper Silurian." The fossils examined by McCoy came from a sandstone range between Whroo and Coy's Diggings. From the same locality (specimens in the National Museum) I have identified (?) *Heliolites;* and from a range of 5 miles north-east of Redcastle there are indeterminate crinoid stems represented by siliceous casts.[2] Lastly, amongst some fossils from Coy's Diggings, Bailieston, received a short time ago from Mr. Thos. Smith, of Newstead, there occur species of the genera *Spirifer* and *Palæoneilo*, which bear a Yeringian aspect, although their exact specific determination is not possible.

Condition of the Specimens.

These fossil corals are, generally speaking, well preserved in their superficial aspect, and also occasionally structurally, but the structure, as is so often the case with silicified fossils, is only brought out by natural weathering. The preparation of a surface by grinding only tends to obliterate what could be previously seen, the effects of the abrasion and polishing merely emphasizing the granular structure of the quartz. That it is a true silicification or replacement of the calcareous skeleton of the coral is shown by the tendency of the original calicular cavities to weather out as in an ordinary fossil limestone coral.

Description of Specimens.

ANTHOZOA, Sub-class TETRACORALLA.

Genus **Streptelasma**, J. Hall.

Streptelasma sp. (Plate XIII., Figs. 1, 2).

Description.—This is a cast of a small rugose coral which has a raised floor to the base of the cup. A mould taken in plasticene shows this elevated floor to be formed by the conjoined internal edges of the septa. The septa number about twenty, and are stout. Numerous minute dissepiments present in the outer zone. There is also a well-marked septal fossula.

But for the presence of a septal fossula, this specimen would have found a more appropriate place in the genus *Lindstroemia*, since the septa are fewer than is usual in *Streptelasma*. The general form of the corallum, so far as can be seen from the cast, is a short cone with an everted calicular margin.

Diameter of cast, 7·5 mm.

Genus **Anisophyllum**, Edwards and Haime.[3]

Anisophyllum howitti, sp. nov. (Plates XIII., Fig. 3; XIV., Figs. 7, 8, 9).

Description.—Corallum small, short, trochoid, and curved. Septa about twenty, alternating long and short; stout and slightly thicker towards the inner extremities. The longer septa in some cases meet, but do not fuse

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[1] Op. supra cit., p. 174.
[2] For a map of this district see Prog. Rep., No. V., Geol. Surv. Vict., facing p. 153.
[3] Milne, Edwards and J. Haime, Brit. Foss. Corals (Pal. Soc. Mon.), 1850, p. LXVI. M. Edwards, Hist. Nat. Coralliaires, 1860, Vol. III., p. 354. Nicholson and Lydekker, Manual of Palæontology, 1889, Vol. I., p. 296, fig. 175.

or tend to form a columella. The cardinal septum is long, extending quite to the centre of the calyx. Its position is indicated by the pinnate arrangement of the external costal striæ. The alar septa are also well developed, hence the reference of this form to *Anisophyllum*, a genus which is elsewhere Devonian.

Dimensions.—Diameter of calyx, 8mm. Length of corallum, 9mm.

Occurrence.—A single silicified and otherwise well-preserved corallum in the Rushworth series.

Sub-class ALCYONARIA.

Genus **Heliolites,** Dana.

HELIOLITES INTERSTINCTA, Linnè sp., var. GIPPSLANDICA, Chapman.

(Plates XIII., Fig. 4; XIV., Figs. 10, 11.)

Heliolites interstincta, L. sp., var. *gippslandica*, Chapman, 1914, Records Geol. Surv. Vict., vol. III., pt. 3, p. 311, pl. LX., figs. 35, 36.

Observations.—There is no doubt that the Cooper's Creek and Rushworth corals belonging to this genus are practically the same varietal form. Differences in the condition of habitat will account for the coralla of the Rushworth examples being as a rule small, and more spreading or mushroom-shaped than the Gippsland specimens. The autopores are often so close together as to almost exclude the coenenchymal portion, reducing the small siphonopores bordering them to two or even one row.

It is rather abundant in this collection; coralla of medium size to small.

Sub-class HEXACORALLA—TABULATA.

Genus **Favosites,** Lamarck.

FAVOSITES GOTHLANDICA, Lamarck (Plate XIV., Fig. 12).

Observations.—Small coralla, some hemispherical in form. Although these fossils from Rushworth are silicified, the mural pores can, in one specimen, be unmistakably seen; they are double on each corallite face.

The species is already known from the newer Silurian beds of Victoria, and it ranges into the Devonian, both here and in New South Wales.

Genus **Pachypora,** Lindström.

PACHYPORA ALTERIVALIS, Chapman (Plates XIII., Fig. 5; XV., Figs. 13, 14, 15, 16).

Pachypora alterivalis, Chapman, 1914, Records Geol. Surv. Vict., vol. III., pt. 8, p. 309, pl. LVII., figs. 28, 29.

Observations.—Several small branches and basal fragments of this coral are present amongst the Rushworth fossils.

The original examples came from the Silurian (Yeringian) of Deep Creek, Thompson River, Gippsland. The length of the largest branches measures 2 cm., equal to the described specimen above mentioned. The basal portion of the corallum shows the coral to have the habit of growth of the Silurian species, *P. lamellicornis*, Lindström[1], whilst in its cylindrical branching habit in its later stages, it resembles the Devonian *P. cervicornis*, de Blainville sp.[2], and the Silurian *P. cristata*, E. and H. sp.[3]

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[1] *Pachypora lamellicornis*, Lindström, 1873, Nagra anteckningar om Anthozoa Tabulata. Öfversigt af Kongl. Vetensk. Akad. Forhandl. Nicholson and Etheridge, jnr., 1878, Journ. Linn. Soc. Zool. Vol. XIII. p. 361, pl. XX. figs. 15–17. Nicholson, 1879, "On the Structure and Affinities of the Tabulate Corals of the Palæozoic Period," p. 80, pl. IV. figs. 2–2*c*.

[2] *Alveolites cervicornis*, De Blainville, 1830, Dict. Sci Nat., t. LX., p. 369. *Pachypora cervicornis*, De Blainv. sp., Nicholson, 1879, Op. supra cit. p. 82, pl. IV. figs. 3–3*d*.

[3] *Favosites cristata*, M. Edwards and Haime, 1851, Pal. Foss. des. Terr. Pal. p. 342. Id., 1854, Brit. Foss. Corals (Pal. Soc. Mon.) p. 260 pl. LXI., figs. 3, 4. *Pachypora cristata*. M. Edw. and H. sp. Nicholson, 1879, op. cit. p. 87, pl. IV. figs. 4–4*b*; pl. V., figs. 1–1*b*.

POLYZOA—TREPOSTOMATA.

Genus **Heterotrypa,** Nicholson.

Heterotrypa rushworthensis, sp. nov. (Plates XIII. Fig. 6; XV. Fig. 17).

Description.—Zoarium small, dendroid. Zooecia 1 mm. across, widely spaced and generally prominent, lips thickened. Acanthopores generally very small, but variable in size, numerous; chiefly grouped round the zooecia, or arranged along the ridges joining adjacent zooecia.

The largest fragment measures 13 mm. in length.

Observations.—Mr. Robert Etheridge, jun., has already described a *Heterotrypa* from the Victorian Silurian beds,[1] to which he has given the name *H. australis*. This species, which was obtained from the Yeringian of Sandy's Creek, Mitchell River, Gippsland, is an encrusting form, and not dendroid as in the present species. It is otherwise distinct in having comparatively large acanthopores, which are disposed in the angles between the zooecia.

Three fragments in the present collection.

Summary.

This small collection of fossils, made by Mr. A. M. Howitt, confirms the Silurian age of these beds, as determined by McCoy. It also conclusively proves them to belong to the later stage, the Yeringian series as shown by the occurrence of *Heliolites interstincta*, var. *gippslandica* and *Pachypora alterivalis*, both of which are characteristic of the Gippsland Yeringian fauna.

The genus *Anisophyllum* is here recorded for the first time from Australia, being previously known as a Devonian fossil from the Lower Hamilton Group of Tennessee, N. America.[2]

The list of determined fossils is as follows :—

Streptelasma sp.
Anisophyllum howitti, sp. nov.
Heliolites interstincta, Linne, sp., var. *gippslandica*, Chapm.
Favosites gothlandica, Lamarck.
Pachypora alterivalis, Chapm.
Heterotrypa rushworthensis, sp. nov.

Explanation of Plates.

Plate XIII.

Fig. 1. *Streptelasma*, sp. Natural cast of corallum. × 2.
Fig. 2. Squeeze from ditto in plasticene, showing fossula. × 2.
Fig. 3. *Anisophyllum howitti*, sp. nov. Showing cardinal and alar septa × 2.

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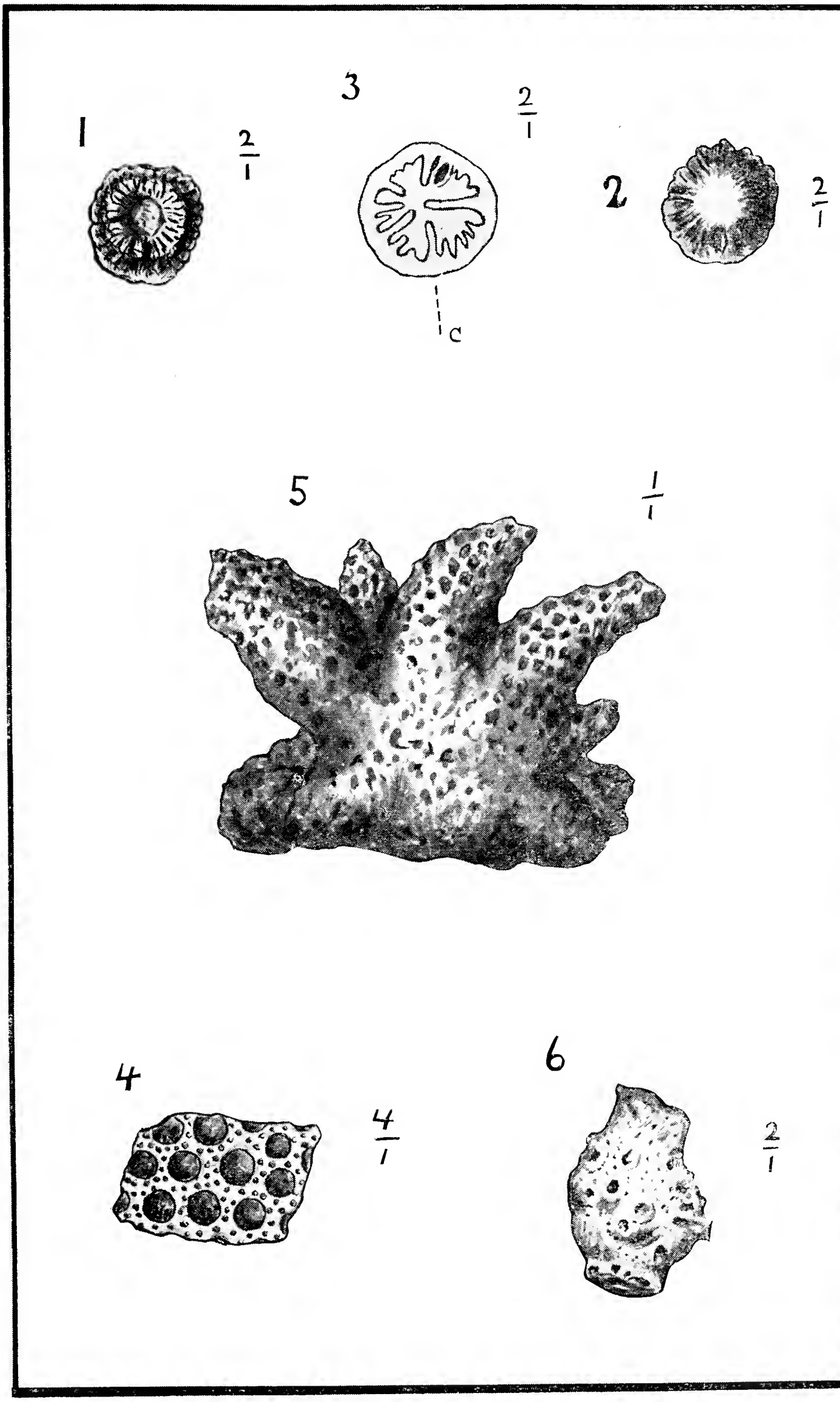
[1] Prog. Rep. No. XI., Geol. Surv. Vict., 1899, p. 34.
[2] The range of *Anisophyllum* is, however, Ordovician to Devonian, according to Eastman–Zittel Text-book of Palæontology, Vol. I., 1913, p. 84.

PLATE XIII.



F.C., del. ad nat.

SILURIAN CORALS, ETC., FROM RUSHWORTH.

Plate XIV.

Fig. 7. $\frac{5}{4}$

Fig. 8. $\frac{5}{4}$

Fig. 9. $\frac{5}{4}$

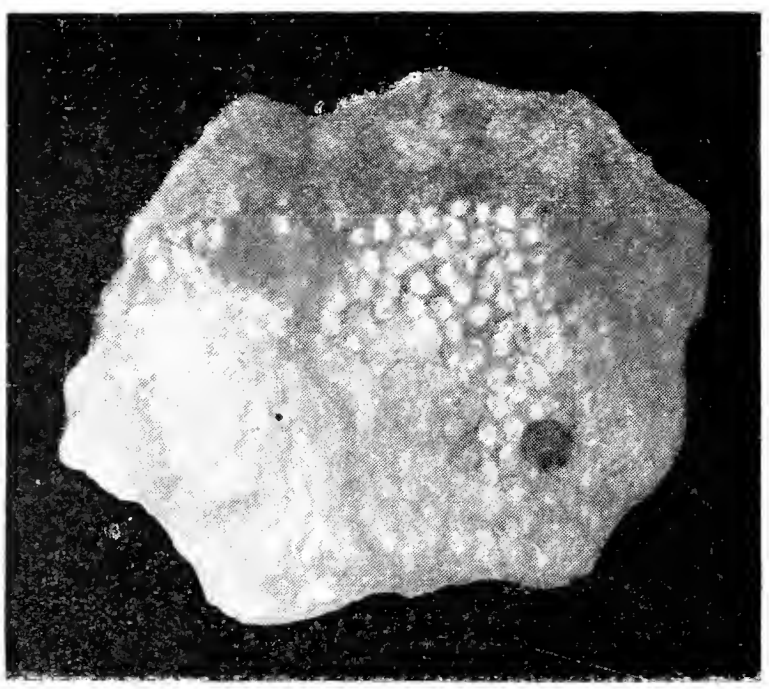


Fig. 10. $\frac{7}{6}$

Fig. 11. $\frac{5}{4}$

Fig. 12 $\frac{5}{4}$

F.C., photo.

SILURIAN CORALS FROM RUSHWORTH.

Plate XV.

Fig. 13. $\frac{5}{4}$

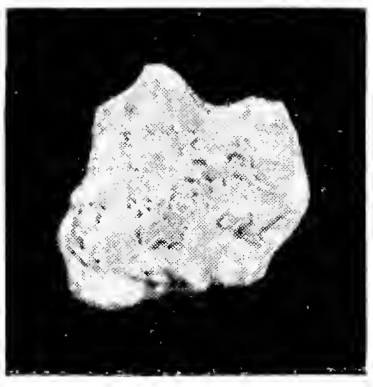


Fig. 14. $\frac{5}{4}$

Fig. 15. $\frac{5}{4}$

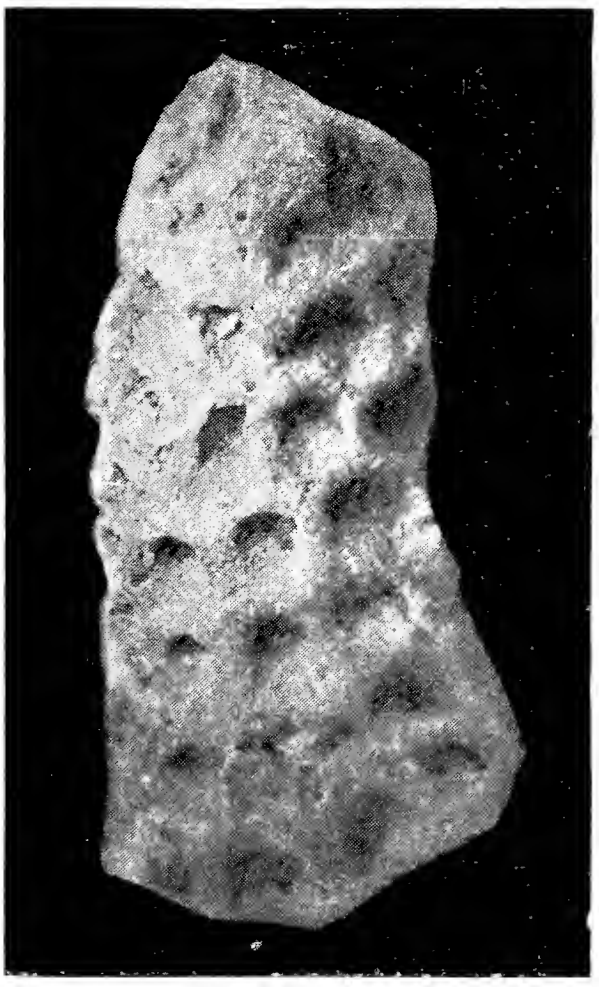


Fig. 16. ×3

Fig. 17. ×5

F.C., photo.

SILURIAN CORALS, ETC., FROM RUSHWORTH.

Fig. 4. *Heliolites interstincta*, L. sp. var. *gippslandica*, Chapm. Part of corallum, showing small proportion of cœnenchyma. × 4.

Fig. 5.—*Pachypora alterivalis*, Chapm. Diagrammatic restoration of corallum, based on fragments from the present series. About natural size.

Fig. 6. *Heterotrypa rushworthensis*, sp. nov. Portion of zoarium. × 2.

XIV.

Fig. 7. *Anisophyllum howitti*, sp. nov. Interior of calyx. $\frac{5}{4}$ nat. size.

Fig. 8. *A. howitti*, sp. nov. Oblique lateral aspect, showing the wide calyx and short cone. $\frac{5}{4}$ nat. size.

Fig. 9. *A. howitti*, sp. nov. Lateral aspect, showing the costal striæ. $\frac{5}{4}$ nat. size.

Fig. 10. *Heliolites interstincta*, Linné, sp. var. *gippslandica*, Chapm. A placentiform corallum, showing the closely spaced autopores. About $\frac{7}{6}$ nat. size.

Fig. 11. *H. interstincta*, L. sp. var. *gippslandica*, Ch. A pisiform corallum. About $\frac{5}{4}$ nat. size.

Fig. 12. *Favosites gothlandica*, Lamarck. A small corallum, showing the walls of the calices in relief. About $\frac{5}{4}$ nat. size.

XV.

Fig. 13. *Pachypore alterivalis*, Chapman. A terminal branch. About $\frac{5}{4}$ nat. size.

Fig. 14. *P. alterivalis* Ch. A basal fragment. About $\frac{5}{4}$ nat. size.

Fig. 15. *P. alterivalis*, Ch. A divergent branch. About $\frac{5}{4}$ nat. size.

Fig. 16. *P. alterivalis*, Ch. A terminal branch (fig. 13), more highly magnified. × 3.

Fig. 17. *Heterotrypa rushworthensis*, sp. nov. × 5.

PALÆOZOIC FOSSILS OF EASTERN VICTORIA. PART IV.[1]

By Frederick Chapman, A.L.S., F.R.M.S., Palæontologist to the National Museum, Melbourne; Hon. Pal. Geol. Surv. Victoria.

(Plates XVI. to XXXII.)

SCHEDULE OF FOSSILS.

A.—LIMESTONE CREEK DISTRICT.

Limestone Creek, near Dead Horse Creek. Nos. 2047–2069. Field No. 34. Plan 9.

Compact grey limestone with abundant shell remains.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2047 (1356, 1357) ..	*Spirifer yassensis*, de Koninck; remains abundant and much comminuted (see pl. XVI., fig. 2). The cement of the limestone is finely crystalline, and contains a large proportion of semi-granular organic material, with occasional larger fragments of echinoids, ostracod valves, and tubular cells of calcareous algæ. There are evidences of shearing and foliation in the rock, and on the solution planes quantities of iron-stained dolomite crystals have been developed

[1] For part III., see Records Geol. Surv., vol. III., pt. 3, 1914, pp. 301–316, pls. XLVI–LXI. The title of this series is here changed to "Palæozoic Fossils," to include other formations intimately connected in this area.

Limestone Creek—*continued*.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2048 (1757)	*Spirifer yassensis* abundant. A thin slice of this rock shows a nearly complete dolomitization in places. Some of the organic layers consist largely of the carapaces of ostracoda which, however, are too fragmentary for determination.
2049 (1758)	*Spirifer yassensis.* In a thin slice seen under the microscope the cement appears to be largely recrystallized as dolomite. Numerous remains of crinoids and ostracoda are present, also a transverse section of a rugose coral, cf. *Zaphrentis.*
2050, 2051, 2053, 2055–2063, 2065–2069	*Spirifer yassensis.*
2052	Spirifers (crushed).
2054 (1759)	*Spirifer yassensis.* A fine-grained matrix of dolomitized crystals and ostracod remains.
2064 (1760)	*?Meristella.* Numerous ostracodal remains occur in sections of this limestone. The matrix of the rock is seen to be partly recrystallized as dolomite, with an occasional quartz crystal.
	Age.—Middle Devonian.

Native Dog Creek. Nos. 2070–2083. Field No. 53B. Plan 13.

2070–2073 and 2080–1	*Tryplasma liliiformis,* Etheridge fil. Internal casts of the calices in mudstone. (See Appendix and pl. XVII., fig. 3.)
2074	Coral, indet.
2075	Traces of fossils, indet.
2076	*Favosites gothlandica,* Lam. A nearly complete conical corallum weathered and showing variably spaced tabulæ and both uniserial and biserial mural pores.
2077–9	Fossil remains, indet.
2082–3	*Heliolites interstincta,* Linné sp. Coralla weathered and partially silicified.
	Age.—Silurian (Yeringian).

Native Dog Creek. Nos. 2084–2094. Field No. 53A. Plan 13.
Grey limestone.

2084–5, 2089, 2093, 2094	Crinoid remains, indet.
2088	Portions of a stem (28 mm. in diam.) of a large crinoid, indet.
2086 (1358), 2090, 2091	*Favosites gothlandica,* Lam. (See Appendix and pl. XX., fig. 10; pl. XXI. and pl. XIII.)
2087 (1359)	*Plasmopora australis,* Etheridge fil. (See Appendix and pl. XIII., fig. 28). Also *Cyathophyllum shearsbii,* Süssmilch (cf. 2134 and Appendix and pl. III., fig. 7).
2092	*?Favosites.*
	Age.—Silurian (Yeringian).

Greenwood's Creek. Nos. 2095–2113. Field No. 45. Plan 11. Fine-grained to blue-grey to black limestone.

2095	*Spirifer yassensis* and *?Athyris* sp.
2096–2113	*S. yassensis.* (See Appendix.)
	Age.—Middle Devonian.

Stony Creek. Nos. 2114–2126. Field No. 57. Plan 8. Massive fossiliferous marble.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2114	Crinoidal limestone, with remains of very large crinoid stems.
2115–6	White saccharoidal limestone with ?crinoid stems.
2117, 2119–20 ..	White crinoidal limestone showing evidence of crushing.
2118	Saccharoidal limestone, with crinoid stems.
2121	Compact white limestone, brecciated.
2122–6	Crinoidal limestone.
	Age.—Probably Middle Devonian.

Cowombat Creek. Nos. 2127–2142. Field No. 46A. Plan 12. Fossiliferous limestone.

2127 (1360–1) ..	*Favosites gothlandica*, Lam. A large corallum, the structure of which is excellently preserved. (See Appendix and pl. XXIII.)
2128–9 (1362–3) ..	*Tryplasma vermiformis*, Eth. fil. Masses of corallites in grey limestone; well preserved. (See Appendix and pl. XVII., figs. 4, 5; pl. XVIII., fig. 6.)
2130	*Favosites gothlandica*, Lam. Part of a medium-sized corallum of a conical form.
2131	*Favosites gothlandica*. A complete corallum which is transversely oval and depressed above. Larger diameter, 10 cm.
2132	*Favosites gothlandica*. Corallum almost flabelliform; the tabulæ are abnormally crowded.
2133	*Tryplasma dendroidea*, Eth, fil. (See Appendix.) A single corallite showing striated epitheca and rapidly tapering base. Also *Favosites* sp.
2134	*Cyathophyllum shearsbii*, Süssmilch. (See Appendix and pl. XIX., fig. 9.) Also *Favosites forbesi*, Edw. and Haime, a species already recorded from the Silurian of Deep Creek, Thomson River (see part III. of this series). Also a new species of fistuliporid, *Fistulipora cowombatensis*. (See Appendix and pl. XXVII., fig. 27.)
2135–6	*Favosites forbesi*, Ed. and H..
2137	*Favosites gothlandica*, Lam.
2138	*Tryplasma vermiformis*, Eth. fil. and a tabulate coral, indet.
2139	*Favosites gothlandica*, Lam. A massive and well-preserved corallum. (See pl. XX., fig. 10; pl. XXI., figs. 12–14.)
2140, 2141 (1368) ..	*Rhizophyllum enorme*, Etheridge fil. (See Appendix and pl. XX., fig. 11.)
2142 (1369, bis., 1370, 1371)	*Heliolites interstincta*, L. sp., var. *gippslandica*, Chapm. (See Appendix and pls. XXIX. and XXX.)
	Age.—Silurian (Yeringian).

Cowombat Creek. Nos. 2143–2171. Field No. 46B. Plan 12. Sandstones and shales.

2143	Impressions of crinoid columnars and brachiopods allied to Atrypa.
2144	Cast of a small coral, indet.
2145	*Atrypa reticularis*, L. sp. and ?*Leptæna*.
2146, 2163	*Atrypa* sp.
2147	Casts of crinoid stems.
2148, 2149, 2150, 2153, 2159, 2160, 2164–7	*Atrypa reticularis*, L. sp.
2151, 2154	Shell remains, indet.
2152	Casts of crinoid columnars and ramose polyzoa, indet.
2155	*Encrinurus* sp. (pygidium).
2156	*Atrypa aspera*, Schlotheim sp.
2157	*Camarotœchia* sp.
2158	*Pleurodictyum* sp.
2161, 2168	Fragments of brachiopods, indet.
2162	*Atrypa reticularis* and other brachiopods and crinoid remains.
2169	Internal casts of *Atrypa reticularis*.
2170 (1762)	Limestone fossil preserved in shale, *Fistulipora cowombatensis*, sp. nov. (See Appendix and pl. XXVII., fig. 26.)
2171	Remains of corals (*Heliolites*), polyzoa and brachiopods, indet.
	Age.—Silurian (Yeringian).

Greenwood's Creek. Nos. 2172–2184. Field No. 45A. Plan 11.
Dark limestone.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2172–2174, 2176–2181, 2183	Bituminous limestone with *Spirifer yassensis*, de Kon.
2175, 2182, 2184 ..	Cf. *Spirifer fimbriatus*, Conrad. Age.—Middle Devonian.

Limestone Creek, near Mac's Creek. Nos. 2185–2208. Field No. 47A. Plan 10.
Dense blue-grey fossiliferous limestone.

2185, 2189	*Spirifer yassensis.*
2202, 2203, 2205–7 ..	*Spirifer*, indet.
2186–88, 2190–99, 2204	Brachiopods, indet.
2200, 2201	Fossils, indet.
2208	Nil. Age—Middle Devonian.

Painter's Creek, Limestone Creek. Nos. 2209–2217. Field No. 60. Plan 6
Laminated white marble.

2209–12, 2214–17 ..	Brecciated limestone and grit with fragments of *Favosites* sp.
2213 (1763)	*Favosites basaltica*, Goldfuss, var. *moonbiensis*, Eth. fil. (See Appendix and pl. XXII., fig. 15; pl. XXIV., fig. 21.) Probably Middle Devonian.

South-west side of Stony Creek. Nos. 2218–2219. Field Nos. 62, 63. Plan 8
Crushed crinoidal limestone.

2218, 2219	Fossils, indet. Age indeterminate from fossil evidence.

Cowombat Creek. Nos. 2220–2221. Field No. 46A. Plan 12.
Impure limestone.

2220–2221	*Tryplasma* sp. Age.—Probably Silurian.

Cowombat Plain. No. 2222.
Silicified limestone.

2222	*Spirifer yassensis*, de Kon. Age.—Middle Devonian.

Near Limestone Creek. Nos. 2466–2468.
Impure brachiopod limestone.

2466–68	*Spirifer yassensis.* Age.—Middle Devonian.

B.—MITTA MITTA RIVER DISTRICTS.

Gibbo River, Benambra. No. 2536. Field No. 69A. Plan 6.
Grey limestone.

2536	A compact grey limestone, largely composed of crinoid stem-joints and ossicles, indet. No indication of age from the fossil contents.

Gibbo River, Benambra. Nos. 2537–2539. Field No. 72. Plan 6.
Dark olive-brown mudstone, with joints, and nodules of limestone.

2537	Crinoid remains and other obscure fossils.
2538 (1764)	Jointed mudstone, with crinoid mould and a corallum of *Heliolites interstincta*, L. sp. var. *gippslandica*, Chapm. (See Appendix and pl. XXVIII., fig. 29.)
2539	Mudstone, with impression of a *Favosites* with small regular calices, indet. Age.—Silurian (Yeringian).

Gibbo River, Benambra. Nos. 2540–2544. Field No. 76. Plan 6.
Impure limestone.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2540	*Favosites forbesi*, Edw. and Haime. An unusually large and massive specimen ; the calices measuring as much as 3 mm. in diameter.
2541 (1376)	*F. forbesi.* A specimen with smaller corallites than the preceding. (See Appendix and pl. XXII., fig. 17.)
2542 (1377–8) ..	*Favosites gothlandica*, Lam. This corallum has been bored by a parasitic plant.
2543 (1379–80) ..	A large massive corallum of *F. gothlandica*, with medium-sized corallites of regular form.
2544	A smaller, cake-like corallum of *F. gothlandica*, with large calices.
	Age.—Silurian (Yeringian).

Mitta Mitta River. Nos. 2545–2560. Field No. 81. Plan 3.
Calcareous shales.

2545	?*Cyathophyllum* (east), and a nodule-shaped corallum of *Favosites forbesi.*
2546	?*Camarotoechia* (mould).
2547	*Cœlospira australis*, sp. nov. (Type, See Appendix and pl. XXXII., fig. 43.)
2548	?*Schuchertella* and *Cœlospira australis*, sp. nov.
2549	Monticuliporoids, indet. ; ?*Plectambonites* (east).
2550	Monticuliporoids ; *Cœnites juniperinus*, Eichw. (See Appendix and pl. XXXII., fig. 36, 37) ; and brachiopods, indet.
2551	Montileuliporoids ; *Orthis* sp. ; *Cœlospira* sp.
2552	*Tryplasma dendroidea*, Eth. fil. (See Appendix.)
2553, 2556	Brachiopods, indet.
2554	*Conocardium bellulum*, Creswell sp. (See Appendix.)
2555	*Fenestella* sp. (impression) ; monticuliporiods ; *Atrypa* sp.
2557	Monticuliporoids, indet.
2558	Monticuliporoids and impressions of crinoid columnars.
2559	?*Atrypa.*
2560	Brachiopod, indet. and free cheek with genal spine of ?*Proetus.*
	Age.—Silurian (Yeringian).

Mitta Mitta River. Nos. 2561–2566. Field No. 82. Plan 3.
Limestone.

2561, 2563, 2566 ..	Hard limestone, with coral and crinoid remains showing on weathered surface.
2562 (1381–2) ..	Hard limestone. In thin section seen to be largely composed of calcareous algæ, including the genus *Sphærocodium*, with a few crinoid joints, coral fragments, polyzoa and ostracoda.
2564 (1383, 1384, and 1384 bis.)	Ditto. Slice No. 1383 shows in addition to the above, a section of coral referred to *Diphyphyllum robustum*, Eth. fil. (See Appendix and pl. XIX., fig. 8.)
2565 (1385)	Compact grey limestone. This section shows a few crinoid ossicles and is largely composed of calcareous algæ, including a comparatively large form with clustered tubes and here-named *Sphærocodium gippslandicum*, sp. nov. (See Appendix and pl. XVI., fig. 1.)
	Age.—Middle Devonian.

Wombat Creek. Nos. 2567–2581. Field No. 89. Plan 2.
Ochreous, fossiliferous shales.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2567, 2568, 2571, 2578	Brachiopod remains, indet.
2569, 2572–4 ..	*Orthis* sp.
2570, 2581	*Atrypa aspera*, Schlotheim sp.
2569, 2578	*Atrypa reticularis*, var. *decurrens*, Chapm.
2576, 2580	*Orthothetes* sp.
2575	Cf. *Heliolites*.
2577, 2580	Crinoid remains.
2579	Fossils, indet.
	Age.—Silurian (Yeringian).

Wombat Creek. Nos. 2582–2652. Field No. 91. Plan 1.
Ochreous, fossiliferous shaly mudstone.

2586, 2589, 2590, 2591, 2600, 2604, 2623, 2627, 2637	*Favosites* sp.
2639	*Tryplasma dendroidea*, Eth. fil. (See Appendix.)
2613, 2615, 2620, 2638	*Heliolites interstincta*, L. sp.
2595	*Alveolites* sp.
2582, 2604	*Heliolites* sp.
2575	Cf. *Heliolites*.
2583, 2605	Corals indet.
2648	Montieuliporoid.
2590, 2591, 2612, 2636, 2638, 2646, 2649	Crinoid ossicles and stem-joints, indet.
2598	*Orbiculoidea diminuens*, sp. nov. (See Appendix and pl. XXXII., figs. 41, 42.)
2587	*Leptæna* ef. *rhomboidalis*.
2620	Cf. *Leptæna*.
2590	*Strophonella* sp.
2620	Cf. *Orthothetes* sp.
2584, 2593, 2594, 2597, 2599, 2605, 2610, 2614, 2616, 2625, 2631, 2632, 2635, 2638, 2650, 2651	*Chonetes* sp.
2639	?*Chonetes*.
2585, 2586	*Orthis* ef. *elegantula*, Dalman.
2587, 2588, 2603, 2604, 2607, 2608, 2611, 2619, 2620, 2624, 2626, 2628, 2635, 2642, 2646	*Orthis* sp.
2604, 2606, 2629, 2635, 2647	Rhynchonellids, indet.
2592, 2605, 2622 ..	*Atrypa reticularis*.
2601, 2607, 2609, 2627, 2647	*Atrypa* sp.
2583, 2589, 2591, 2596, 2601–3, 2617, 2636, 2640, 2641, 2643	Braehiopods, indet.
2609	*Actinopteria* sp.
2636	Bivalved shell, indet.
2634, 2644, 2652 ..	?Trilobite fragments, indet.
2618, 2621, 2630, 2633, 2645	Fossils, indet.
	Age.—Silurian (Yeringian).

Wombat Creek. Nos. 2653–2656. Field No. 92. Plan 2
Ochreous, fossiliferous shaly mudstone.

2655	*Favosites* sp.
2654	Crinoid remains, indet.
2653	*Chonetes* sp.
2655, 2656	*Orthis* sp.
	Age.—Silurian (Yeringian).

Wombat Creek. Nos. 2657–2659. Field No. 93. Plan 2.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2657–9	Calcareous algæ and crinoid remains. These fossils yield no decided evidence, but, judging by the next series, are of Silurian age.

Wombat Creek. Nos. 2660–2661. Field No. 95. Plan 1.
Impure limestone.

2660	Crinoid remains, seen on weathered surface.
2661 (Slide)	The weathered surface shows a fine radiating corallum of *Favosites forbesi*. In thin section much calcareous algæ and many ostraeoda.
	Age.—Silurian (Yeringian).

Wombat Creek. Nos. 2662–2670. Field No. 99. Plan 1.
Ochreous, fossiliferous mudstone.

2662, 2666	*Tryplasma liliiformis*, Eth. fil. (Casts and moulds).
2668, 2670	*Favosites* sp.
2668	Crinoid remains
2669, 2670	*Orthis* cf. *rustica*, Sowerby.
2665	*Orthis* sp.
2665	*Atrypa* sp.
2663	*Conchidium* sp.
2664, 2667	Brachiopods, indet.
2665	*Encrinurus* sp. (pygidial fragment).
	Age.—Silurian (Yeringian).

Wombat Creek. Nos. 2671–2672. Field No. 100. Plan 1.
Grey mudstone.

2671	Branching coral or polyzoan, indet.
2671, 2672	*Chonetes* sp.
2671, 2672	*Orthis canaliculata*, Lindström.
2671	*Nucula opima*, J Hall, var. *australis*, Chapman.
	Age.—Silurian.

Gibbo River. No. 2673. Field No. 109. Plan 8.
Ash or mudstone.
Obscure fossil remains, indet.

Gibbo River. Nos. 2674–2694. Field No. 110. Plan 8.
Indurated dark-grey shales.

2674–76, 2679, 2686, 2690, 2691, 2693	*Tryplasma liliiformis*, Eth. fil.
2683	*Tryplasma* sp.
2685	?*Tryplasma* (young form).
2681	*Halysites lithostrotonoides*, Eth. fil. (See Appendix.)
2689	Cf. *Heliolites*.
2677–80, 2682, 2684–7, 2691	*Acanthoclema flexuosa*, sp. nov. (See Appendix and plate XXIV., fig. 20, and pl. XXXII., figs. 38–40.) Nos. 2680 and 2684 show the basal portion of the zoarium.
2694	Indet, fossils.
	Age.—Silurian (Yeringian).

Wombat Creek. No. 2695. Field No. 111. Plan 1.
Shales with crinoid columns. Probably of Silurian age.

Gibbo River. Nos. 2696–2697. Field No. 120. Plan 8.
Shales with crinoid remains. Probably of Silurian age.

Mitta Mitta River. Nos. 2698–2718. Field No. 125. Plan 5.
Limestones with thin argillaceous bands, and showing much shearing in places.

Regd. No. (Slice No. in parentheses.)	Fossils, with Remarks.
2698 (1390, 1390A) ..	This sheared coral limestone is seen in thin section to contain the carapaces of ostracoda and coralla of *Halysites orthopteroides*, Eth. fil. (See Appendix.)
2699	*Halyites orthopteroides* seen on smoothed and weathered surface of rock.
2700 (1391, 1392, 1393)	In thin sections, *Halysites* cf. *orthopteroides* (1391—see Appendix and pl. XXV.; pl. XXVI., fig. 24); *H. pycnoblastoides* (1392—Appendix and pl. XXVI., fig. 25); and ostracoda (1393—Appendix and pl. XXXI., fig. 34).
2701	*Heliolites* sp. and other corals, indet.
2702, 2703, 2704 ..	Corals indet, without slicing.
2705 (1394, 1395) ..	In thin section, a sheared limestone with indeterminate corals and ostracoda (pl. XXXI., fig. 35).
2706	*Tryplasma* sp. and *Heliolites* sp.
2707	*Heliolites* sp. and *Halysites* sp.
2708	?*Cyathophyllum* (longitudinal fracture through cortex of large corallite).
2709	Sheared corals, indet.
2710	*Heliolites* sp.
2711	?*Favosites*; ?*Heliolites*.
1712–4, 2717 ..	Corals indet., without slicing.
2715 (1396)	In thin section the rock is seen to contain ostracods; a rugose coral, indet.; *Halysites* sp.; and crinoid remains.
2716 (1765, 1765 bis.) ..	These slices show the rock specimen to contain portion of a well-preserved corallum of *Favosites gothlandica*, Lam.
2718 (1766)	In thin section, showing numerous ostracoda.
	Age.—Silurian (Yeringian).

APPENDIX ON THE FOSSILS.

PLANTÆ. Class ALGÆ.

Genus **Sphærococodium,** Rothpletz.

Sphærocodium gippslandicum, sp. nov. (Plate XVI., Fig. 1).

Description.—Thallus forming fungiform pellets, consisting of fasciculated masses of radiating, dichotomously branched, single-celled filaments. Cells ovoid or short cylindrical, measuring about ·15 mm. in diameter. The figured pellet measures about 5 mm. in diameter.

Relationships.—The cells of the related species *S. gotlandicum*[1] and *S. bornemanni*[2] are much smaller, having a breadth of ·02 to ·025 mm. The former came from the Silurian of Gotland, the latter from the St. Cassian beds of South Tyrol (Upper Alpine Trias).

Occurrence.—In compact blue limestone associated with *Diphyphyllum robustum*, of Middle Devonian age. Junction of Wombat Creek and the Mitta Mitta River, Gippsland. (Nos. 2562, 2564, 2565.)

[1] Rothpletz. Ueber Algen und Hydrozoen im Siluri von Gotland und Oesel. Kongl. Svensk. Vetensk. Akad. Handl., vol. XLIII., No. 5, 1908, p. 7, pl. I., figs. 5, 6; pl. II., figs. 1–4.
[2] Op. supra cit., p. 7, pl. I., figs. 2–4.

ANIMALIA. Class ANTHOZOA.

Fam. Cyathophyllidae.

Genus **Cyathophyllum**, Goldfuss.

Cyathophyllum shearsbii, Süssmilch. (Plates XVIII., Fig. 7; XIX., Fig. 9).

Cyathophyllum shearsbii, Etheridge, jun., MS., 1904, Rec. Aust. Mus., vol. V., pt. 5, p. 288 (footnote). Süssmilch, 1914, Geology of New South Wales (figure only), fig. 14B, facing p. 44.

Observations.—The present identification of this coral has been confirmed by means of an examination of some corals from Yass donated to the National Museum by Mr. A. J. Shearsby, F.R.M.S. It has not been described, but has been often quoted as *Cyathophyllum shearsbii*, Eth. fil. MS. As will be seen by the above reference, Mr. Süssmilch has figured a fine section of the coral which renders its identification with our Yass and Gippsland specimens indisputable. There are about 50 principal and 50 secondary septa in the coral. The dissepiments are numerous in the outer third and externally convex. Halfway towards the axis at the ends of the secondary septa, the dissepiments become vesicular in character, gradually disappearing towards the centre of the coral. The coral figured on plate XIX., fig. 9, is a little over 2 cm. across. One average specimen from Yass measures 3·5 cm.

It is of great interest to note that this coral is found in the Yass district, parish of Boambolo, associated in No. 1 Limestone with some corals similar to those of the Limestone Creek area where *C. shearsbii* occurs. Thus Mr. L. F. Harper has recorded[1] from No. 1 Limestone—*Cyathophyllum shearsbii*, *Tryplasma dendroidea*, *Favosites gothlandica*, *Favosites* (dendroid), *Stromatopora*, *Pentamerus* (*Conchidium*) *etheridgei*, and *Spirifer* sp. indet. The fauna noted here from the Mitta Mitta, as associated with *C. shearsbii*, are—*Tryplasma dendroidea*, *T. vermiformis*, *Rhizophyllum enorme*, *Favosites forbesi*, *F. gothlandica*, *Heliolites interstincta*, var. *gippslandica* and *Fistulipora cowombatensis*,

Occurrence.—In grey limestone. Native Dog Creek (No. 2087. In fossiliferous limestone, Cowombat Creek (No. 2134). Silurian (Yeringian).

Genus **Diphyphyllum**, Lonsdale.

Diphyphyllum robustum, Etheridge fil. (Plate XIX., Fig. 8).

Diphyphyllum robustum, Etheridge, jun., 1899, Rec. Geol. Surv. N.S. Wales vol. VI., pt. 3, p. 153, pl. XXXII., figs. 1, 2; pl. XXXVII., fig. 2.

Observations.—The horizontal section of the corallite shown as above is indistinguishable from Etheridge's Moore Creek specimens. The Moore Creek Limestone of New South Wales has been placed in the Tamworth series by Dr. W. N. Benson,[2] and in his columnar section of the Devonian series of the Tamworth District,[3] it forms the base of his "Upper Middle Devonian." The palæontological evidence is therefore definite, notwithstanding some difficult problems as regards field relationships in the Victorian area of the Mitta Mitta.

Occurrence.—Fossiliferous limestone. Junction of Wombat Creek and Mitta Mitta River. Plan No. 3. (No. 2564.)

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[1] Records Geol. Surv. N.S. Wales, vol. IX., pt. 1, 1909, p. 40.
[2] "The Geology and Petrology of the Great Serpentine Belt of New South Wales." Proc. Linn. Soc. N.S. Wales, vol. XL., pt. 3, 1915, p. 551.
[3] *Idem ibid.*, p. 549.

Genus **Tryplasma,** Lonsdale.

Tryplasma vermiformis, Etheridge fil. (Plates XVII., Figs. 2–3.; XVIII., Fig. 6).

Tryplasma vermiformis, Etheridge, jun., 1907, Mem. Geol. Surv. New South Wales, Pal. No. 13, p. 83, pl. XI., fig. 1 ; pl. XXIII., figs. 4, 5.

Observations.—Some well-preserved coralla of this species are found in the grey limestone of Cowombat Creek, Limestone Creek (Nos. 2128–9, 2138). It is allied in some respects to *T. lonsdalei*, Eth. fil.[1], and in fact might at first sight be mistaken for it. The differences are apparent, however, in a good series of examples. The distinctive features of *T. vermiformis* as compared with *T. lonsdalei* are, as given by Mr. Etheridge, (1) the limited number of septa, (2) the regularity and simplicity of the tabulæ, (3) apparent absence of radiciform processes and fistulæ.

The distribution of the various species of *Tryplasma* in these Victorian sediments makes it appear strongly suggestive that the hydrographic condition of their surroundings influences the form either in direct modification or, as regards selective areas shown by each species.

Occurrence.—Cowombat Creek, N.E. Gippsland. Silurian (Yeringian). In grey limestone (Nos. 2128, 2129, 2138).

In New South Wales this species has been recorded from county Ashburnham.

Tryplasma dendroidea, Etheridge fil.

Tryplasma dendroidea, Etheridge, jun., 1907, Mem. Geol. Surv. New South Wales, Pal. No. 13, p. 87, pl. XIV., fig. 1 ; pl. XV., fig. 5 ; pl. XVIII., figs. 2–6 ; pl. XIX., fig. 6 ; pl. XXII., figs. 11–15 ; pl. XXIII., fig. 9 ; pl. XXIV., fig. 6 ; pl. XXVII., figs. 3, 4.

Observations.—Several fragmentary examples of this species, showing the striated epitheca, regular and complete tabulæ, and general dendroid habit, are not uncommon. The corallites average about 12 mm. in diameter.

Occurrence.—In the fossiliferous limestone of Cowombat Creek (2133) ; in the calcareous shales of the Mitta Mitta River (2552) ; and in the fossiliferous shaly mudstone of Wombat Creek (2639). In New South Wales it appears to be confined to the Yass District.

Tryplasma liliiformis, Etheridge fil. (Plate XVII., Fig. 3).

Tryplasma liliiformis, Etheridge, jun., 1907, Mem. Geol. Surv. N. S. Wales, Pal. No. 13, p. 95. pl. XIV., figs, 2, 3 ; pl. XV., figs. 2–4 ; pl. XVII., figs. 7, 8 ; pl. XXIV., fig. 1 ; pl. XXV., fig. 8 ; pl. XXVII., figs. 1, 2.

Observations.—It is very interesting to note the occurrence of the above species of *Tryplasma* for the first time in Victoria. The impure limestone of Native Dog Creek is squeezed and distorted, but the characteristic open and shallow cup of this coral with other distinctive structural features, may be clearly made out. By its appearance at a few localities only, amongst a large series of fossils of similar age, it evidences a local though abundant development due probably to suitable conditions for the growth of this particular form.

Occurrence.—T. liliiformis is found in the mudstones and impure limestone of Native Dog Creek, Limestone Creek District (2070–3 and 2080–1) and in the ochreous mudstone (as casts) of Wombat Creek (2662, 2666). Numerous examples also occur in the indurated dark-grey shales of the Gibbo River, Mitta Mitta River District (2674–76, 2679, 2686, 2690, 2691, 2693).

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[1] Rec. Geol. Surv. N.S. Wales, vol. II., pt. 1., 1890, p. 15, pl. I. Also Mem. Geol. Surv. N.S. Wales, Pal. No. 13, 1907, p. 77, pl. X.; pl. XI., figs, 2–4 ; pl. XII., fig. 1 ; pl. XIX., fig. 4 ; pl. XXV., fig. 5; pl. XXVI., figs. 1–7.

It is an abundant and fairly well-distributed fossil in the New South Wales Silurian, occurring at Hatton's Corner and Derrengullen Creek in the Yass District ; and near Orange in parish Barton, county Ashburnham.

Fam. Cystiphyllidæ.

Genus **Rhizophyllum,** Lindström.

Rhizophyllum enorme, Etheridge fil. (Plate XX., Fig. 11).

Rhizophyllum enorme, Etheridge, jun., 1903, Rec. Geol. Surv. N. S. Wales, vol. VII., p. 232, pl. XLVII.

Observations.—This peculiar rugose and operculate coral is here noted for the first time in Victoria. The specimen from Cowombat Creek is less than normal size, measuring somewhat over 4 c.m in length, against Mr. Etheridge's specimens which measured 6 and 7 cm. respectively. The present example, however, may easily have been larger when complete, as both the apex and the outer rim have been eroded. The epitheca is strong and transversely corrugated.

In some respects the present coral resembles Shearsby's *R. robustum,*[1] but the latter is of shorter conoidal form and the vesicular inner structure much finer. In the section of the Victorian coral the vesicular structure of the wall passes into tabulate structure as it enters the basal area of the cup.

Occurrence.—Cowombat Creek, N.E. Gippsland, Silurian (Yeringian). In grey limestone. Nos. 2140 and 2141.

The locality in New South Wales given by Mr. Etheridge is Boree Creek. portion 3, parish Cudal, county Ashburnham.

Fam. heliolitidæ.

Genus **Heliolites,** Dana.

Heliolites interstincta, var. gippslandica, Chapman (Plates XXIX., Figs. 30, 31 ; XXX., Figs. 32, 33).

Heliolites interstincta, L. sp., var. *gippslandica,* Chapman, 1914, Rec. Geol. Surv. Vict., vol. III., pt. 3, p. 311, pl. LX., figs. 35, 36.

Observations.—The corallum of this variety attains a large size. It is a prominent component of the Yeringian coral fauna of Victoria, and has lately been recorded by the writer from Rushworth (see preceding report). At the latter locality the coralla were much smaller than usual, and tending to take a mushroom shape, probably through adverse hydrographic conditions. The species itself occurs at Native Dog Creek in presumably Silurian mudstones.

Occurrence.—In fossiliferous limestone at Cowombat Creek, and in dark olive-brown mudstone on the Gibbo River at Benambra.

Genus **Plasmopora,** Edwards and Haime.

Plasmopora australis, Etheridge fil. (Plate XXVIII., Fig. 28).

Plasmopora australis, Etheridge, jun., 1899, Geol. Surv. Vict., Prog Rep. No. XI., p. 33, pl. A, fig. 11 ; pl. B, figs. 5, 6.

Observations.—The present specimen was found in the Limestone Creek area, whilst Mr. Etheridge's example occurred not very far off, at Wombat Creek, and in limestone of precisely the same age. The corallum in our specimen bears out Etheridge's suggestion that the form was hemispherical. It measures only about 9 mm., as against that of $1\frac{1}{2}$ inches in the Wombat Creek specimen ; but this difference may be explained on the supposition that the section in the former case was taken through the basal area. The autopores in the present specimen measure slightly under 1 mm. in diameter.

Occurrence.—In grey limestone, Native Dog Creek. (No. 2087.)

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[1] Geol. Mag., Dec. V., vol. III., 1906, p. 548, pl. XXVI., figs. 1–6.

Fam. Favositidæ

Genus **Favosites,** Lamarck.

Favosites gothlandica, Lamarck (Plates XX., Fig. 10; XXI., Figs. 12–14; XXIII. Figs. 18, 19).

Favosites gothlandica, Lamarck, Etheridge, jun., 1899. Rec. Geol. Surv. New South Wales, vol. VI., pt. 3, p. 162, pls. XXII. and XXIII.

Observations.—The coralla of this well-known form are frequent in the Silurian portion of this series of rocks from the Limestone Creek District The corallites compare closely in size with the measurements given by Dr. H. A. Nicholson in his "Tabulate Corals," 1879, p. 46. The coralla when complete are seen to be roundly conical, that is, the point of attachment is blunt and the growing surface spheroidal. In specimen 2091 the roughly fractured corallum shows the vertical rows of corallites with their uniserial mural pores in relief. In specimen 2127, which by the way is well preserved, th· vertical slice shows the coral to have been fractured by minute thrusts which have displaced the vertical walls by three stages of ·25 mm. each. No. 2130 is a conical-shaped corallum. The weathered surface shows the spacing and arrangement of the tabulæ very distinctly. A curious point in regard to the spacing of the tabulæ was noticed here, namely, where the corallites are vertical the tabulæ are normal and regular, and where they recurve the tabulæ tend to become rapidly numerous and even crowded together, as in some flattened Devonian forms like *F. multitabulata*. Thus even the manner of spacing of the loculi cannot be relied upon as an entirely safe factor for specific determination. No. 2542, from the Gibbo River, Benambra, shows the corallum to have been invaded by a boring fungus, the hyphæ of which have subsequently been differentially stained by limonite. This staining has evidently taken place synchronously with, or subsequently to, the joint-fracturing of the limestone, since the corals in the rock are filled with the same material.

Occurrence.—Limestone Creek series: Native Dog Creek (Nos. 2076, 2086, 2090, and 2091). Cowombat Creek (Nos. 2127, 2130, 2131, &c.).

Mitta Mitta River series: Gibbo River, Benambra (No. 2542).

Age.—Silurian (Yeringian).

Favosites forbesi, Edwards and Haime (Plate XXII., Figs. 16, 17).

Favosites forbesi, Edwards and Haime, 1855, Mon. Brit. Foss. Corals (Pal. Soc. Mon.), p. 258, pl. LX., figs. 2, 2*a–g*. Chapman, 1914, Rec. Geol. Surv. Vict., vol. III., pt. 3, p. 308, pl. LIII., fig. 9; pl. LVI., fig. 27.

Observations.—The specimens from the Mitta Mitta River District (Gibbo River), referred to the above species, are irregular in the growth of the corallum. One is a massive form (No. 2540), approaching the Silurian example described by Prof. Nicholson. Another example (No 2541) has smaller calices, and the corallum is abruptly truncated on the summit by a deposit of calcareous mud with crinoid remains. The dwarfing of the coral may have ensued from the beclouding of the water in which they lived, by the sediment, and which may have finally killed it.

Occurrence.—Cowombat Creek (Nos. 2135, 2136). Gibbo River (Nos. 2540, 2541). Mitta Mitta River (No. 2545). Wombat Creek (No. 2661).

Age.—Silurian (Yeringian).

FAVOSITES BASALTICA, Goldfuss, var. MOONBIENSIS, Etheridge fil. (Plates XXII., Fig. 15; XXIV., Fig. 21).

Favosites basaltica, Goldf. var. *moonbiensis*, Etheridge, jun., 1899, Rec. Geol. Surv. N. S. Wales, vol. VI., p. 164, pl. XXIV., figs. 1, 2; pl. XXIX., fig. 2.

Observations.—This coral here occurs in a brecciated limestone grit, of a peculiar mottled colour, the white being dappled with pale pink and green. The fragmentary pieces of coral are well preserved, and on fractured and weathered faces show the mural pores disposed evenly in a single row along the length of each corallite or prismatic face. As in Etheridge's specimens from Moonbi, N.E of Tamworth, N. S. Wales, the diameter of the individual corallites is uniformly 1 mm. An apparent discrepancy between the Victorian and New South Wales specimens, in regard to the spacing of the tabulæ, as shown in the present photomicrograph (pl. XXIV., fig. 21), is explained by the fact that the tabulæ vary in their spacing in different parts of the corallum, those near the base being crowded, as in Etheridge's figured variety, whilst those near the peripheral layers are more widely spaced, as in Etheridge's variety, *salebrosa*, of the same species.[1]

This variety occurs in the Tamworth series (Upper Middle Devonian) of New South Wales.

Occurrence.—Limestone Creek, opposite the junction of Painter's Creek No. 2213). Probably Middle Devonian.

GENUS **Cœnites**, Eichwald.

COENITES JUNIPERINUS, Eichwald (Plate XXXII., Figs. 36, 37).

Cœnites juniperinus, Eichwald, 1829, Zool. Spec., vol. I., p. 179. Nicholson, 1879, Tabulate Corals, p. 133, pl. VI., figs. 5, 5*a*–*b*.

Observations.—A mould of a small cylindrical and branching corallum of *Cœnites* occurs in the Mitta Mitta series associated with *Tryplasma* and *Conocardium*. It compares very closely in every respect with Eichwald's species, in the form of the calicular apertures, as well as in the general habit of the corallum. *C. juniperinus* is a Silurian species in Great Britain (Dudley), Russia, and North America (Lockport). The genus *Cœnites* has already been recorded from Victoria by Mr. R. Etheridge, jun.,[2] who has noted an indeterminate species from Sandy's Creek, Gippsland, which differs in habit from ours in having an encrusting corallum, and in this respect is compared by Mr. Etheridge with *C. labrosus*, Edw. and H., *C. laminata*, J. Hall sp., and *C. lunulata*, Nich. and Hinde.

Occurrence.—Calcareous shales. Mitta Mitta River (No. 2550). Silurian (Yeringian).

Fam. HALYSITIDÆ.

GENUS **Halysites**, Fischer.

HALYSITES LITHOSTROTONOIDES, Etheridge fil.

Halysites lithostrotonoides, Etheridge, jun., 1904, Mem. Geol. Surv. N.S. Wales, Pal. No. 13, pt. I., p. 23, pl. I., figs. 2, 3; pl. VI., figs. 1, 2; pl. IX., fig. 4.

Observations.—This species is represented for the first time in Victoria, in the hardened blue mudstone of the Gibbo River, N.E. Gippsland. It occurs in association with other corals, as *Tryplasma liliiformis*, Eth. fil. The impressions of the calices and the regular straight alignment of the grouping to form the corallum, are very distinct. In New South Wales it is found in the Silurian of Spring Creek, Co. Ashburnham, and Molong.

Occurrence.—Gibbo River (No. 2681). Silurian (Yeringian).

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[1] Loc. cit., p. 166, pl. XXI., figs, 3–5; pl. XXVII., figs. 1, 2.
[2] Geol. Surv. Vict., Prog. Rep., No. XI., 1899, p. 34, pl. A., figs. 9, 10; pl. B, fig. 1.

HALYSITES ORTHOPTEROIDES, Etheridge fil. (Plates XXV., Figs. 22, 23 ; XXVI., Fig. 24).

Halysites orthopteroides, Etheridge, jun., 1904, Mem. Geol. N. S. Wales, Pal. No. 13, pt. I., p. 25, pl. III., fig. 1 ; pl. VII., figs. 4, 5.

Observations.—The labyrinthine fenestrules and the characters of the tabulæ are sufficient to define this species, as occurring in thin sections of the Mitta Mitta limestone. Fig. 24 of these plates is taken from a sheared example, much of the limestone of this district being deformed by dynamo-metamorphism. This is the first occurrence of *H. orthopteroides* in Victoria. It has been recorded from the Silurian of Co. Wellington, New South Wales.

Occurrence.—In the grey limestone of the Mitta Mitta River, N.E. Gippsland (Nos. 2698, 2699, ?2700).

HALYSITES PYCNOBLASTOIDES, Etheridge fil. (Plate XXVI., Fig. 25).

Halysites pycnoblastoides, Etheridge, jun., 1904, Mem. Geol. Surv. N.S. Wales, Pal. No. 13, pl. I., p. 32, pl. IV., figs. 1, 2 ; pl. VIII., figs. 5, 6. Yabe, 1915, Rep. Tôhoku University, Sendai, 2nd Ser., Geology, vol. IV., pt. 1., p. 36, pl. IX., figs. 3, 4.

Observations.—These Victorian examples, the first recorded, are well-defined in section. They show the oval, robust character of the autopores with their septal spines and the ill-defined mesopores. The differences between this form and the somewhat related *H. sussmilchi* are well shown in the present specimen. It is the rarest of the three species of the genus found here. In New South Wales it occurs at Spring Creek, Co. Ashburnham. Dr. Yabe recently described this form from Ta-Wan-Gai, near Y-chang, China.

Occurrence.—In the grey Silurian limestone of the Mitta Mitta River, N.E. Gippsland (No. 2700).

Class POLYZOA.

Fam. FISTULIPORIDÆ, Order CYCLOSTOMATA.

GENUS **Fistulipora**, McCoy.

FISTULIPORA COWOMBATENSIS, sp. nov. (Plate XXVII., Figs. 26, 27).

Description.—Zoarium cylindrical or subrotund. Length of one example 28 mm ; diameter, 13·5 mm. In horizontal section the autopores or zooecia are circular and average 1·2 mm. longer diameter. The mesopores are smaller, angular to lobate, and average 1 mm. in diameter. Walls of the autopores and mesopores thin ; numerously perforated. In longitudinal section the mesopores are seen to be short and broad proportionally.

Relationships.—The above species is distinct from the already described *Fistulipora victoriæ*, Chapman,[1] in having a coarser and more irregular structure, the autopores being often ill-defined and the mesopores sinuate or bilobed ; and further, the thin walls of the mesopores are numerously perforate.

Two species of the genus from the Niagara Formation (Wenlockian) of North America somewhat resemble the present species, viz., *F. lockportensis*, Bassler,[2] and *F. tuberculosa*, J. Hall sp.[3] The former, however, has much larger autopores, whilst the latter exhibits a more open and irregular mesoporal structure in longitudinal section.

Observations.—A point of great interest in connexion with this species is the constant occurrence of mural pores in the cyst-like walls of the mesopores. In regard to this structure Dr. Nicholson has remarked on their

[1] See this publication, vol. III., pt. 3, 1914, p. 310, pl. LVIII., fig. 31 ; pl. LIX., figs. 32–34.
[2] U.S. Geol. Surv., Bull. No. 292, Ser. C. Geol. and Pal. 78, 1906, p. 23, pl. VII., figs. 1–3.
[3] *Rhinopora tuberculosa*, J. Hall. Nat. Hist. N. York, Pal. II., 1852, p. 170, pl. XLE., figs. 4*a–c*. *Fistulipora tuberculosa*, J. Hall sp., Bassler, op. cit., 1906, p. 23, pl. VII., figs. 11–15 ; pl. VIII., figs. 7, 8 ; pl. XXIII., fig. 14.

general absence, or if they occur, the forms are of the genuine favositoid type.[1]

Occurrence.—In fossiliferous Silurian limestone; Cowombat Creek, N.E. Gippsland (No. 2134).

Order Cryptostomata. Fam. Rhabdomesontidæ.

Genus **Acanthoclema,** J. Hall.

Acanthoclema flexuosa, sp. nov. (Plates XXIV., Fig. 20; XXXII., Figs. 38–40).

Description.—Zoarium moderately slender and branching; branches cylindrical or slightly flattened; basal portion swollen. Diameter of branches, 2 to 4 mm. Apertures circular to ovate, inclined to be ostiolate, arranged in a vertical series more or less quincuncially. Number of rows usually about ten. Interspaces between the apertures occupied by a depressed vertical ridge. Zooecia disposed at an acute angle to the axis, but opening at the surface nearly at right angles. The primitive part of the zooecia bend sharply down to the axis. Acanthopores numerous, producing a roughened surface, seen in well-preserved moulds. Length of zoarium reaching 5 cm. or more.

Observations.—This form is probably the same as that referred to by Prof. McCoy as allied to *Trematopora ostiolata*, J. Hall[2] from the Silurian of Cooper's and Deep Creeks, Thompson River, Gippsland. *T. ostiolata*, whilst bearing a general outward resemblance to the above form, belongs to the trepostomate group, whereas the Victorian species now described is a cryptostomate form. The systematic arrangement of the zooecia in the two genera mentioned differ greatly, as seen in cross section, the intermediate vesicular tissue and central canal of the zoarium of *Trematopora* being absent in *Acanthoclema*.

No sufficiently well-preserved specimens which could be cut for microscopic examination were found in this series, but in the general determination of this form from casts and moulds the writer has been greatly helped by a collection of palæozoic polyzoa lately deposited in the National Museum by Dr. R. S. Bassler, of Washington, U.S.A.

Acanthoclema asperum, J. Hall sp.,[3] differs from the above in its more slender branches and nearly circular zooecial apertures.

Occurrence.—Well-preserved casts and moulds in indurated dark-grey Silurian shales; Gibbo River, N.E. Gippsland (Nos. 2677–80, 2682, 2684–7, 2691, 2694).

Class Brachiopoda.

Fam. Discinidæ.

Genus **Orbiculoidea,** d'Orbigny.

Orbiculoidea diminuens, sp. nov. (Plate XXXII., Figs. 41, 42).

Description.—Shell minute; upper or ventral valve subcircular, depressed, with a slightly subcentral pedicle notch. Surface of valve having eleven or more concentric and rounded ridges with interspaces deeply excavated. Greatest width, 3·25 mm.

Relationships.—The Victorian specimen is a well-preserved cast in hardened mudstone, and a wax squeeze shows the minutest details of the valve. It agrees with Sowerby's species, *O. rugata*[4] from the Wenlock and Upper Ludlow of England and Wales, in the circular outline, the depressed form and the low vertex with close concentric rugæ. Taking into consideration the facts

[1] "The Genus Monticulipora and its Subgenera," 1881, pp. 93, 94.

[2] Geol. Surv. Vict., Prog. Rep., No. 5, 1878, p. 175.

[3] *Trematopora aspera*, Hall, Nat. Hist. N. York, Pal. II., 1852, p. 154, pl. XLA., figs. 10*a–c*. *Batostomella aspera*, Hall sp., Nickles and Bassler, Bull. U.S. Geol. Surv., No. 173, 1900, p. 189. *Acanthoclema asperum*, Hall., sp. Bassler, *ibid.*, No. 292, 1906, p. 58, pl. XXI. figs, 3–5; pl. XXIV., figs. 7–9; pl. XXV. figs. 17–20.

[4] *Orbicula rugata*, Sowerby, 1839, in Murchison's Silurian System, pl. V., fig. 11. *Discina rugata*, Sow, sp., McCoy, 1852, Brit. Pal. Foss., p. 190. Davidson, 1866, Pal. Soc. Mon., Brit. Foss. Brach., pt. VII. No. 1, p. 63, pl. V., figs. 9–18.

that the pedicle notch in the Victorian species is more central, and the dimensions much less than in the British species,[1] it is better to regard the two forms as distinct.

Another apparently related form is J. Hall's *O. tenuilamellata*,[2] which, however, has more numerous growth-lines, sharper ridges, and less depressed valves. This species was recorded from the limestone at Lockport, N.Y. State (Niagara or Wenlock series).

Occurrence.—In fossiliferous, shaly Silurian mudstone; Wombat Creek, N.E. Gippsland (No. 2598).

Fam. Spiriferidæ.

Genus **Spirifer,** Sowerby.

Spirifer yassensis, De Koninck (Plate XVI., Fig. 2).

Spirifer yassensis, de Koninck, 1876, Foss Pal. Nouv. Galles du Sud, p. 104, pl. III., fig. 6. Mem. Geol. Surv. N. S. Wales, Pal. No. 6, 1898, p. 83, pl. III., fig. 6. Chapman, 1905, Proc. R. Soc. Vict., vol. XVIII. (N.S.), pt. I., p. 16, pl. V., figs, 2, 3.

Observations.—In the rock specimens from Limestone Creek this typically Devonian spirifer is especially abundant. The shells occur in an impure limestone, which shows regular bedding due to enormous numbers of this brachiopod, together with a larger quantity of mud than usual. The shells in this type of rock tend to become almost micromorphic, and are apparently stunted by the influx of terrigenous material during the life of the fauna. The nature of the rock is shown in plate XVI., fig. 2.

Occurrence.—Limestone Creek, near Dead Horse Creek (Nos. 2047–69). Middle Devonian.

Fam. Cœlospiridæ.

Genus **Cœlospira,** J. Hall.

Cœlospira australis, sp. nov. (Plate XXXII., Figs. 43, 44).

Description.—Holotype. Dorsal valve nearly hemispherical, with a straight hinge-line, relatively high area and widely rounded anterior border. The slightly convex surface is medially sulcate and ornamented with about eight broad, bifurcating riblets, the lateral ones strongly incurved in the median area. Both riblets and interspaces are marked with fine raised concentric threads.

Supplementary specimens (Nat. Mus., 792–3) from Cowombat (A. W. Howitt coll.) show the ventral valve (paratype No. 792) to be moderately convex, with about ten rounded or sub-acute riblets, bifurcating near the anterior margin and crossed with concentric, raised growth-lines which become slightly tegulate anteriorly.

Dimensions.—Length of holotype (anterior to extremity of beak), 5 mm.; width, 7·25 mm. Length of paratype, 5 mm.; width, 7 mm.

Observations.—This species had, many years ago, been identified in the museum collection by myself as "*Atrypa hemisphærica*," to which form it is undoubtedly related. Additional specimens collected by the Victorian Geological Survey from N.E. Gippsland enable me to diagnose it as a new species of the genus *Cœlospira*, J. Hall, which genus has not been previously recorded for Australia.[3] It may be remarked in passing that Davidson subsequently referred Sowerby's species ("*Atrypa hemisphærica*") to the genus *Leptocœlia*, but a later examination by Hall and Clarke leads them

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[1] *O. rugata* averages 16 mm., the Victorian species being only 3.25 mm.

[2] *Orbicula tenuilamellata*, J. Hall, Pal. N. York, vol. II., 1852, p. 250, pl. LIII., fig. 3. *Orbiculoidea* (*Schizotreta*) *tenuilamellata*, J. Hall sp., Hall and Clarke, *ibid.*, vol. VIII., pt. II., 1894, pl. IV*e*. figs. 9–11.

[3] De Koninck has recorded ?*Atrypa hemisphærica*, Sowerby from the Silurian of Duntroon, N.S. Wales; the description according with the British form and not with our new species. See Mem. Geol. Surv. N.S. Wales Pal. No. 6, 1898, p. 26.

to place it with *Cœlospira* (see ref. those authors, footnote below). The Australian species possesses some definite characters which separate it from the northern form. In the first place, *Cœlospira hemisphærica* is not so typically hemispherical in the valve outlines as the Australian; the figures given by Davidson[1] tallying with his description "ventral valve sub-hemispherical." Another essential difference is the greater number of riblets in the British and American species, that is, 12 to 18 against 8 or 10 in the Australian. A third feature is the greater average dimensions, as compared with the Australian species, being very nearly twice the diameters.

Cœlospira acutiplicata, Conrad sp.[2] has a similar ornament to the Australian species, but the valves are more circular in outline and not so widely transverse. This species, by the way, has lately been referred by E. M. Kindle[3] to the genus *Anoplotheca*.

Occurrence.—In calcareous shales; Mitta Mitta River (Nos. 2547 holotype, 2548, 2551). Also in dark mudstone; Cowombat, Forest Hill, coll., by Dr. A. W. Howitt; specimens in the Nat. Mus. coll. (Nos. 792–3). Silurian (Yeringian).

Class Pelecypoda.

Fam. Conocardiidæ.

Genus **Conocardium,** Bronn.

Conocardium bellulum, Cresswell sp.

Pleurorhynchus bellulus, Cresswell, 1893, Proc. R. Soc. Vict., vols.V. (N.S.), p. 43, pl. IX., fig. 6.

Conocardium bellulum, Cresswell sp., Chapman, 1908, Mem. Nat. Mus., Melb., No. 2, p. 45. Id., 1913, Rep. Austr. Assoc. Adv. Sci., vol. XIV., Melbourne, p. 226.

Observations.—A very finely preserved mould of the anterior and main part of both valves occurs here. The mode of preservation enables one to see the minute structure of the shell in this genus, as being composed of hollow prisms, which in the present mould are represented by limonite mud-casts.

C. bellulum is apparently restricted to the Yeringian series in Victoria, and is therefore useful as an index fossil. It has not been previously recorded from N.E. Gippsland, having been found only at Lilydale, the Upper Yarra (Junction of Woori Yallock and Yarra), and at Deep Creek, Thomson River, Gippsland.

Occurrence.—In calcareous shales; Mitta Mitta River (No. 2554). Silurian (Yeringian).

Class Crustacea.

Ostracoda spp. (Plate XXXI., Fig. 34).

Observations.—The majority of examples of sectional tests seen in the slides resemble those of *Bythocypris hollii*, Jones, a form which has already been recorded from the Silurian (Yeringian) of Victoria.[4] The precise determination of even the genus in such sections is unsafe, and we can only refer to the form in a tentative way. Other examples in section are more compressed than the above, and may belong to bythocyprids of a type like *Bythocypris phaseolus*, Jones.[5]

Occurrence.—The Ostracods here under discussion occur in the pale grey limestone with *Halysites* from the Mitta Mitta River, N.E. Gippsland (No. 2700, c.). Silurian (Yeringian).

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[1] ?*Atrypa hemisphærica*, Sow., Davidson, Mon. Brit. Foss. Brach., pt. VII., No. 11. (Pal. Soc. Mon.), 1867, p. 136, pl. XIII., figs. 23–30*a*. See also *Atrypa hemisphærica*, Sowerby, Sil. Syst., 1839, p. 637, pl. XX., fig. 7. *Cœlospira hemisphærica*, Sow. sp., Hall and Clarke, Pal. N. York, vol. VIII., Brach., pt. I., 1894, p. 136, pl. LXXXII., figs. 1–4.

[2] See Hall and Clarke, *ibid.*, 1894, pl. LIII., figs. 32–39.

[3] U.S. Geol. Surv., Bull. No. 508, p. 84, pl. VI., figs. 1–5.

[4] Proc. R. Soc. Vict., vol. XVIII. (N.S.), pt. I., 1904, p. 310, pl. XIV.,figs. 9*a–b*; pl. XV., figs. 1*a–e*, 2*a–c*.

[5] See *id., ibid.*, p. 311, pl. XV., figs. 5*a–b*.

LIST OF FOSSILS IDENTIFIED AND DESCRIBED IN THE PRESENT REPORT.

Name.

Devonian.

Plantæ.

Sphærocodium gippslandicum, Chapm.

Anthozoa.

Diphyphyllum robustum, Eth. fil.
cf. Zaphrentis.
Favosites basaltica, Goldf. var. moonbiensis, Eth. fil.

Crinoidea.

Crinoid remains, indet.

Brachiopoda.

Spirifer yassensis, de Koninck.
S. cf. fimbriatus, Conrad.
(?) Meristella.
(?) Athyris.

Silurian.

Anthozoa.

Cyathophyllum shearsbii, Süssmilch.
Tryplasma dendroidea, Eth. fil.
T. liliiformis, Eth. fil.
T. vermiformis, Eth. fil.
Rhizophyllum enorme, Eth. fil.
Heliolites interstincta, L.
H. ,, var. gippslandica, Chapm.
Plasmopora australis, Eth. fil.
Favosites gothlandica, Lam.
F. forbesi, Edw. and Haime.
Pleurodictyum sp.
Cœnites juniperinus, Eichw.
Alveolites sp.
Halysites lithostrotonoides, Eth. fil.
H. orthopteroides, Eth. fil.
H. pycnoblastoides, Eth. fil.

Name.

Silurian—*continued.*

Crinoidea.

Crinoid remains, indet.

Polyzoa.

Fistulipora cowombatensis, Chapm.
Fenestella sp.
Acanthoclema flexuosa, Chapm.

Brachiopoda.

Orbiculoidea diminuens, Chapm.
Orthis cf. rustica, Sow.
Orthis canaliculata, Lindström.
Leptæna cf. rhomboidalis, Wilckens sp.
(?) Plectambonites.
Strophonella sp.
(?) Schuchertella.
Chonetes sp.
Conchidium sp.
Camarotœchis sp.
Atrypa reticularis, L. sp.
A. ,, var. decurrens, Chapm.
A. aspera, Schlotheim sp.
Cœlospira australis, Chapm.

Pelecypoda.

Nucula opima, J. Hall, var. australis, Chapm.
Conocardium bellulum, Cresswell sp.
Actinopteria sp.

Trilobita.

(?) Proetus.
Encrinurus sp.

Ostracoda.

cf. Bythocypris hollii, Jones, &c.

EXPLANATION TO PLATES.

XVI.

Fig. 1. *Sphærocodium gippslandicum*, sp. nov. Section through thallus, Middle Devonian. Mitta Mitta River. No. 2565 (Sl. 1385). × 13.

Fig. 2. *Spirifer yassensis*, de Koninck. Section of massive limestone showing structure of shells and nature of matrix. Middle Devonian. Limestone Creek. No. 2047 (Sl. 1357). × 18.

XVII.

Fig. 3. *Tryplasma liliiformis*, Etheridge fil. Mudstone cast of corallum. Silurian (Yeringian). Native Dog Creek. No. 2071. Nat. size.

Fig. 4. *Tryplasma vermiformis*, Etheridge fil. Mass of corallites in grey limestone. Silurian (Yeringian). Cowombat Creek. No. 2128. Nat. size.

Fig. 5. *T. vermiformis*, Eth. fil. Transverse section of the same enlarged. No. 2128 (Sl. 1363). × 7.

XVIII.

Fig. 6. *Tryplasma vermiformis*, Eth. fil. Vertical section. Silurian (Yeringian). Cowombat Creek. No. 2128 (Sl. 1362). × 7.

Fig. 7. *Cyathophyllum shearsbii*, Süssmilch. Transverse section of portion of corallum. Silurian (Yeringian). Native Dog Creek. No. 2087 (Sl. 1359). × 13.

XIX

Fig. 8. *Diphyphyllum robustum*, Eth. fil. Transverse section. Middle Devonian. Mitta Mitta River. No. 2564 (Sl. 1383). × 13.

Fig. 9. *Cyathophyllum shearsbii*, Süssmilch. Transverse section. Silurian (Yeringian). Cowombat Creek. No. 2134 (Sl. 1365). × 7.

XX.

Fig. 10. *Favosites gothlandica*, Lamarck. Corallum showing stages of growth, marked by weathered platforms. Silurian (Yeringian). No. 2139. Nat. size.

Fig. 11. *Rhizophyllum enorme*, Etheridge fil. Vertical section through cup, showing vesicular dissepiments and tabulæ. Silurian (Yeringian). Cowombat Creek. No. 2141 (Sl. 1368). × 7.

XXI.

Fig. 12. *Favosites gothlandica*, Lam. Transverse section of corallites, showing partial infilling with quartz. Silurian (Yeringian). Cowombat Creek. No. 2139 (Sl. 1761). × 13.

Fig. 13. *Favosites gothlandica*. The same. showing the general variation amongst the corallites. Silurian (Yeringian). Cowombat Creek. No. 2139 (Sl. 1761). × 7.

Fig. 14. *F. gothlandica*. A longitudinal to slightly oblique section, showing tabulæ. Silurian (Yeringian). Cowombat Creek. No. 2139 (Sl. 1761 bis). × 7.

XXII.

Fig. 15. *Favosites basaltica*, Goldfuss, var. *moonbiensis*, Etheridge fil. Section through corallum embedded in breccia. Probably Middle Devonian. Painter's Creek, Limestone Creek. No. 2213. Nat. size.

Fig. 16. *Favosites forbesi*, Edw. and Haime. Transverse section of corallum. Silurian (Yeringian). Wombat Creek. No. 2661. × 13.

Fig. 17. *F. forbesi*. Vertical section of corallum. Silurian (Yeringian). Gibbo River, Benambra. No. 2541 (Sl. 1376). × 13.

XXIII.

Fig. 18. *Favosites gothlandica*. Transverse section of a well-preserved corallum, showing septal spines and mural pores. Silurian (Yeringian). Cowombat Creek, Limestone Creek. No. 2127 (Sl. 1360). × 13.

Fig. 19. *F. gothlandica*. Vertical section of corallum from same locality. No. 2127 (Sl. 1360). × 13.

XXIV.

Fig. 20. *Acanthoclema fiexuosum*, sp. nov. Zoaria in indurated shale. Silurian (Yeringian). Gibbo River, Benambra. No. 2679. Nat. size.

Fig. 21. *Favosites basaltica*, var. *moonbiensis*, Eth. fil. Longitudinal section of corallum. Probably Middle Devonian. Painter's Creek, Limestone Creek. No. 2213 (Sl. 1763). × 13.

XXV.

Fig. 22. *Halysites orthopteroides*, Etheridge fil. Section of corallum. Silurian (Yeringian). Mitta Mitta River. No. 2698 (Sl. 1390). × 13.

Fig. 23. *H. orthopteroides*, Eth. fil. Vertical section, showing tabulæ. From the same locality. No. 2698 (Sl. 1390). × 13.

XXVI.

Fig. 24. *Halysites* cf. *orthopteroides*, Eth. fil. Section through corallum. Silurian (Yeringian). Mitta Mitta River. No. 2700 (Sl. 1391). × 13.

Fig. 25. *Halysites pycnoblastoides*, Eth. fil. Partially oblique section through corallum. Silurian (Yeringian). Mitta Mitta River. No. 2700 (Sl. 1392). × 13.

XXVII.

Fig. 26. *Fistulipora cowombatensis*, sp. nov. Section of zoarium. Cotype. Silurian (Yeringian), Cowombat Creek. No. 2170 (Sl. 1762). × 13.

Fig. 27. *F. cowombatensis*, sp. nov. Section of zoarium. Cotype. No. 2134. (Sl. 1364). × 7.

XXVIII.

Fig. 28. *Plasmopora australis*, Eth. fil. Vertical section of corallum. Silurian (Yeringian). Native Dog Creek. No. 2087 (Sl. 1359). × 7.

Fig. 29. *Heliolites interstincta*, L., var. *gippslandica*, Chapman. Section of corallum cut obliquely. Silurian (Yeringian). Gibbo River, Benambra. No. 2538 (Sl. 1764). × 13.

XXIX.

Fig. 30. *Heliolites interstincta*, L. var. *gippslandica*, Chapm. Transverse section of corallum. Silurian (Yeringian). Cowombat Creek. No. 2142 (Sl. 1371). × 7.

Fig. 31. The same. Vertical section. No. 2142 (Sl. 1369). × 7.

XXX.

Fig. 32. *H. interstincta*, var. *gippslandica*. Section approximately transverse. Silurian (Yeringian). Cowombat Creek. No. 2142 (Sl. 1369A). × 7.

Fig. 33. *H. interstincta*, var. *gippslandica*. Section approximately vertical. Same locality. No. 2142 (Sl. 1370). × 7.

XXXI.

Fig. 34. Ostracodal limestone in thin section. Silurian (Yeringian). Mitta Mitta River. No. 2700 (Sl. 1393). × 13.

Fig. 35. Sheared limestone. Silurian (Yeringian). Mitta Mitta River. No. 2705 (Sl. 1394). × 13.

XXXII.

Fig. 36. *Cœnites juniperinus*, Eichwald. Mould of corallum in calcareous shale. Silurian (Yeringian), Mitta Mitta River. Nat. size.

Fig. 37. *C. juniperinus*, Eich. Drawing of wax squeeze from mould of the above specimen. × 8.

Fig. 38. *Acanthoclema flexuosum*, sp. nov. Portion of zoarium restored from a wax squeeze. Hard grey shales. Silurian (Yeringian). Gibbo River, Benambra. No. 2679. × 8.

Fig. 39. *A. flexuosum*, sp. nov. Natural cast of zooecia. No. 2679. × 8

Fig. 40. *A. flexuosum*, sp. nov. Internal wall of cast. No. 2679. × 8.

Fig. 41. *Orbiculoidea diminuens*, sp. nov. A wax squeeze from holotype. Shaly mudstone. Silurian (Yeringian). Wombat Creek. No. 2598. × 8.

Fig. 42. *O. diminuens*, sp. nov. The same in profile. × 8.

Fig. 43. *Cœlospira australis*, sp. nov. Dorsal valve. Holotype. Silurian (Yeringian). Mitta Mitta River. No. 2547. × 3.

Fig. 44. *C. australis*, sp. nov. Ventral valve. Paratype. Silurian (Yeringian). Cowombat, Forest Hill. A. W. Howitt coll. × 3.

Plate XVI.

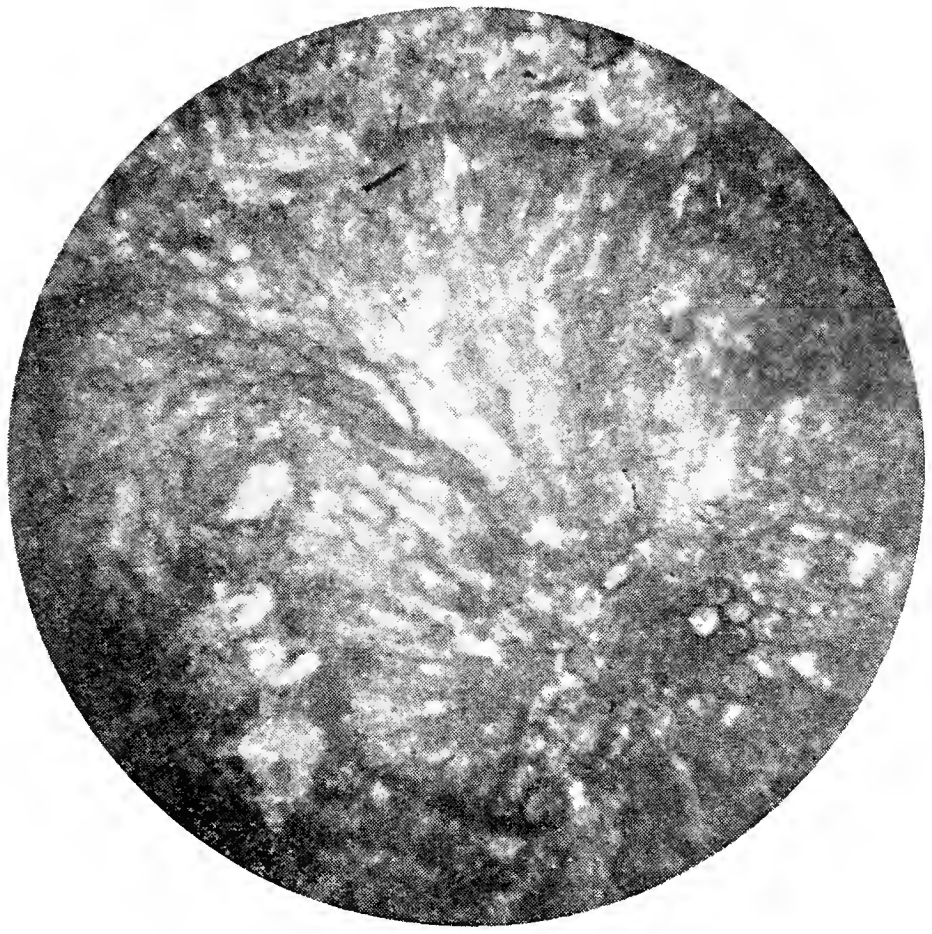


Fig. 1. ×13

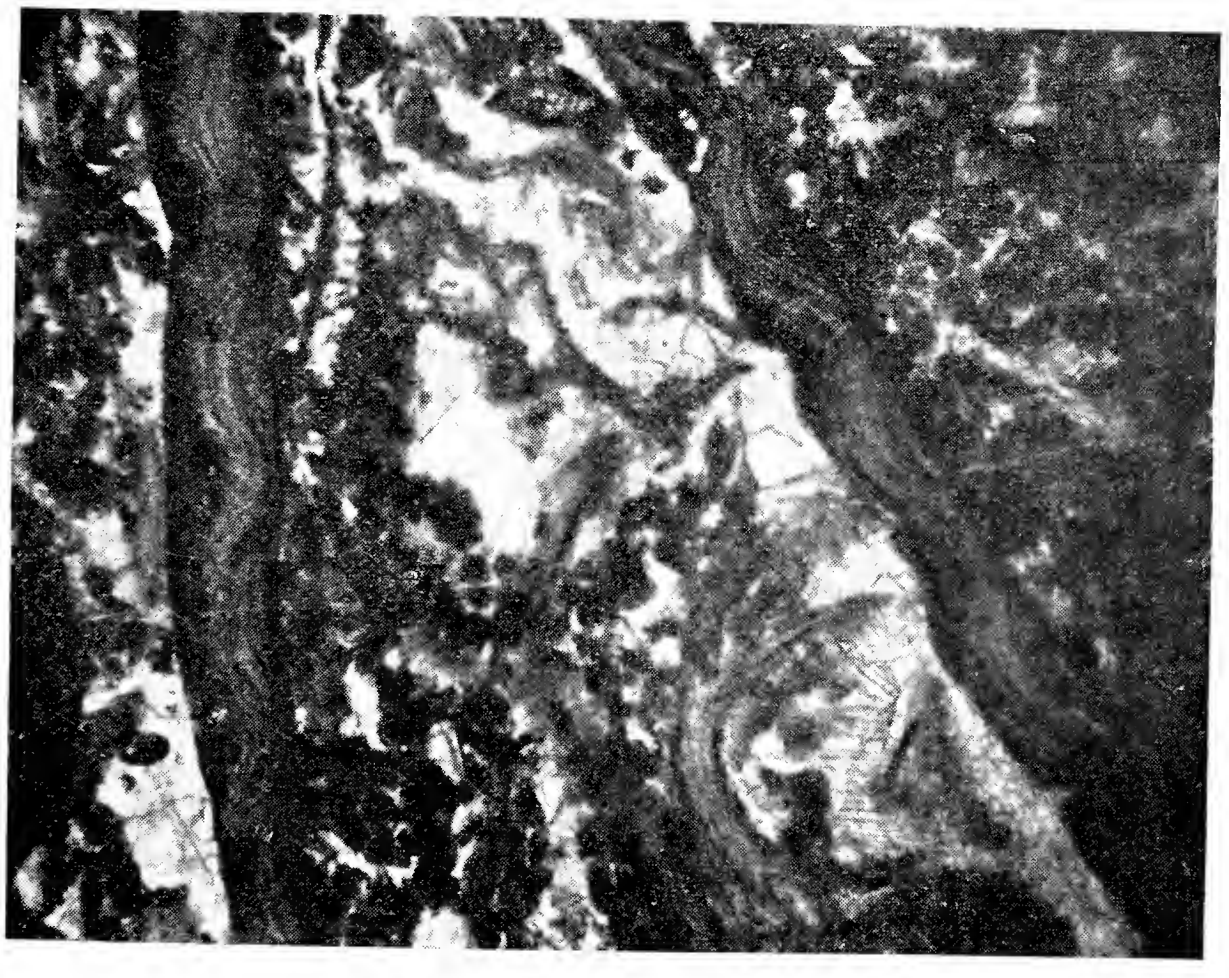


Fig. 2. ×18

F.C., photo.

SPHÆROCODIUM GIPPSLANDICUM, CHAPM. AND SPIRIFER LIMESTONE.

Plate XVII.

Fig. 3. Nat. size.

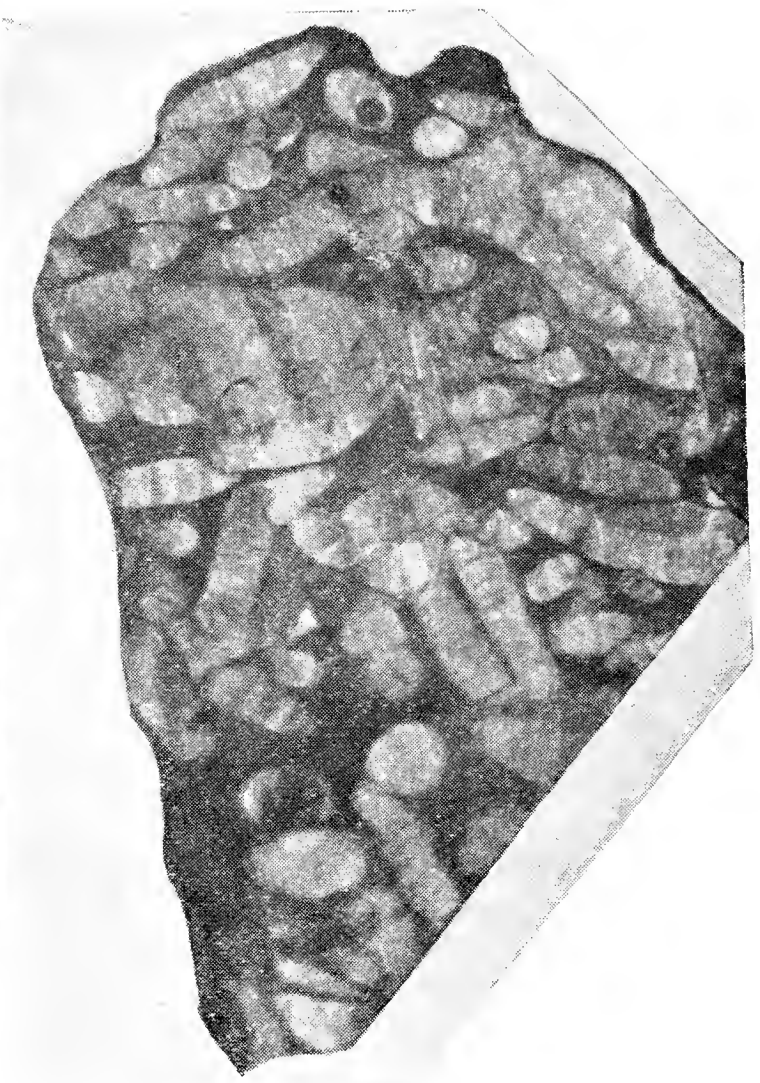


Fig. 4. Nat. size.

Fig. 5. ×7

F.C., photo.

TRYPLASMA LILIIFORMIS, ETH. FIL. AND T. VERMIFORMIS, ETH. FIL.

Plate XVIII.

Fig. 6. ×7

Fig. 7. ×13

F.C., photo.

TRYPLASMA VERMIFORMIS, ETH. FIL. AND CYATHOPHYLLUM SHEARSBII, SÜSSMILCH.

PLATE XIX.

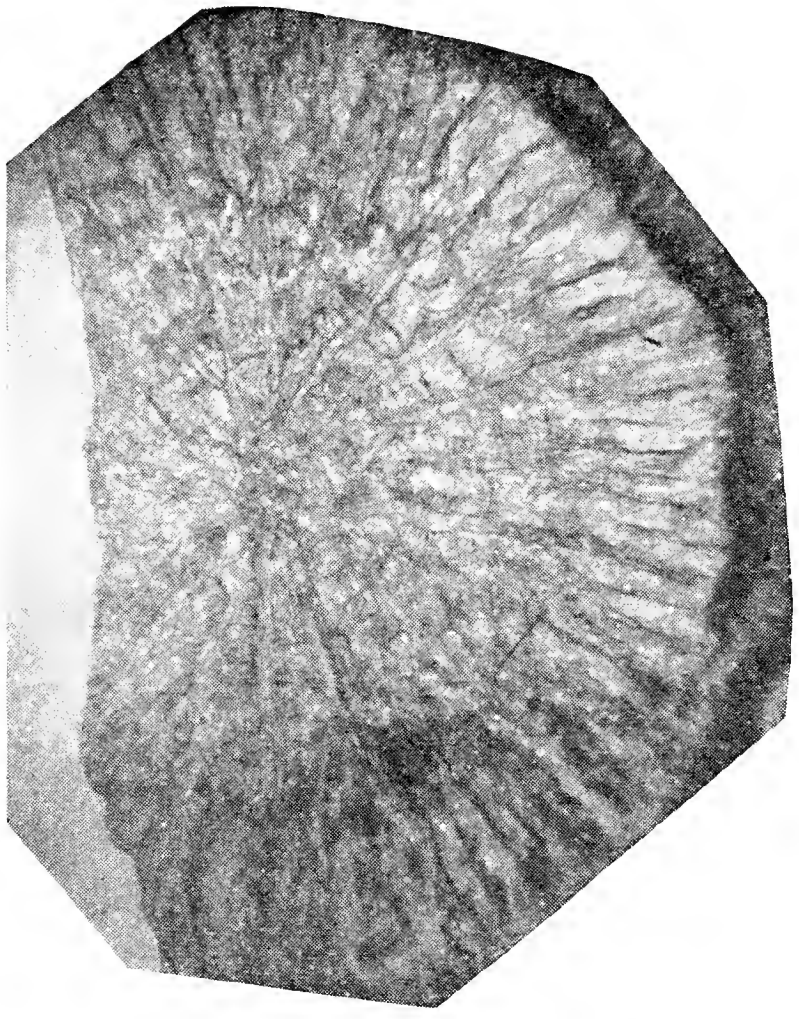


FIG. 8. ×13

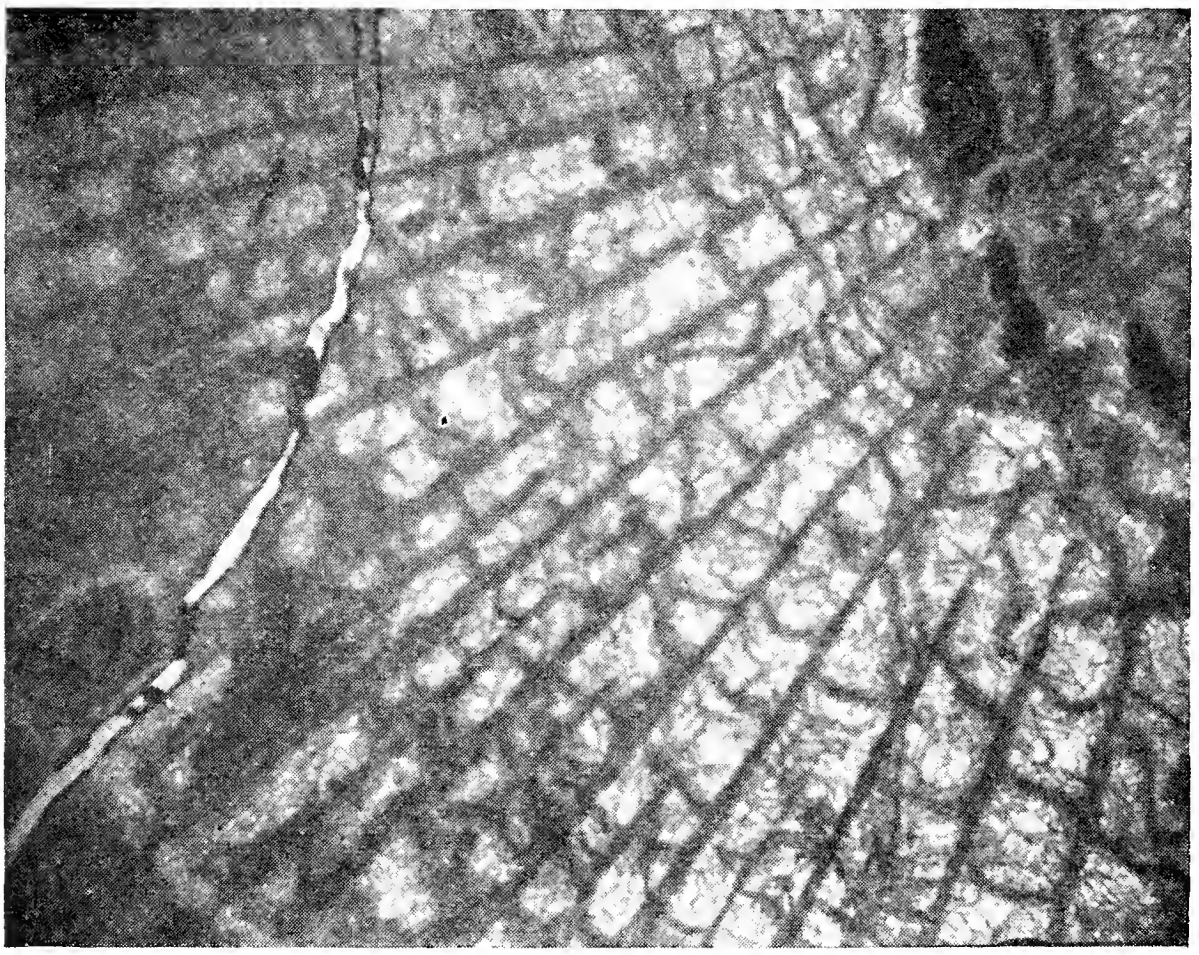


FIG. 9. ×7

F.C., photo.

DIPHYPHYLLUM ROBUSTUM, ETH. FIL. AND CYATHOPHYLLUM SHEARSBII, SÜSSMILCH.

Plate XX.

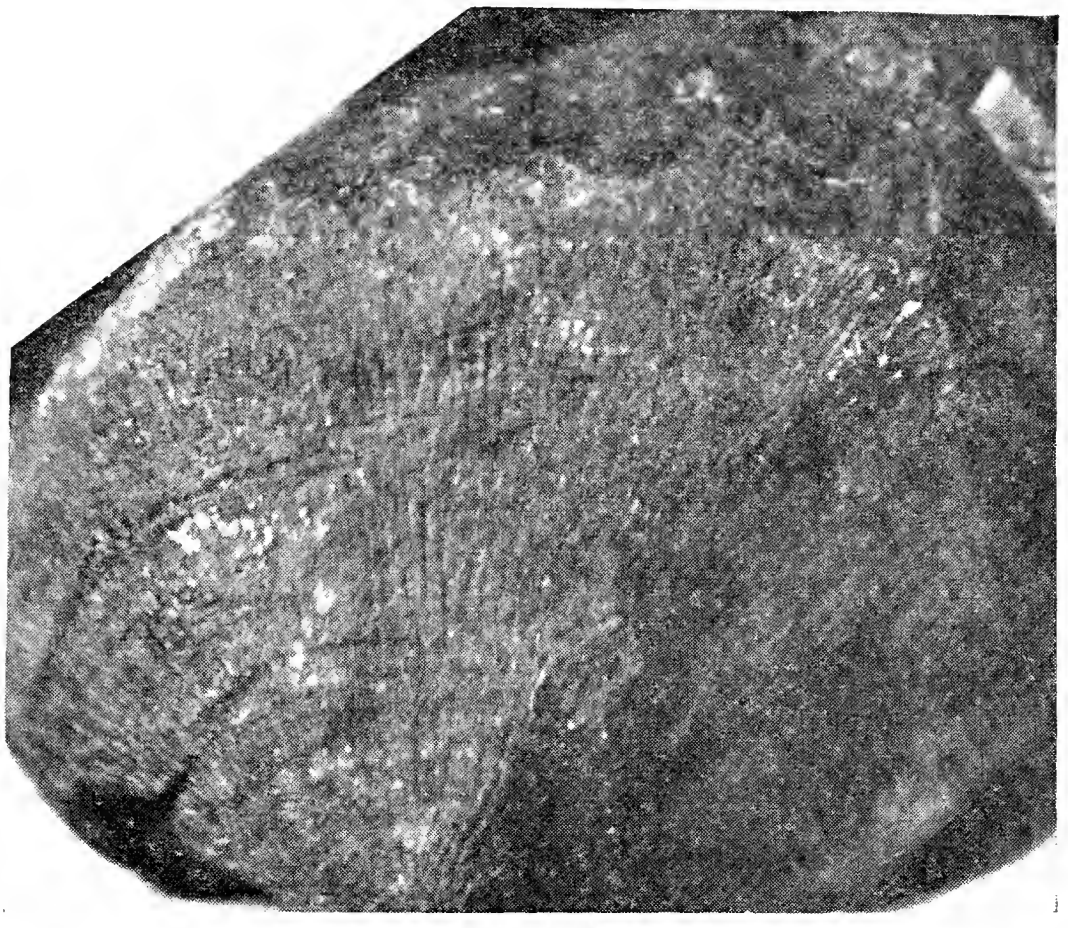


Fig. 10. Nat. size.

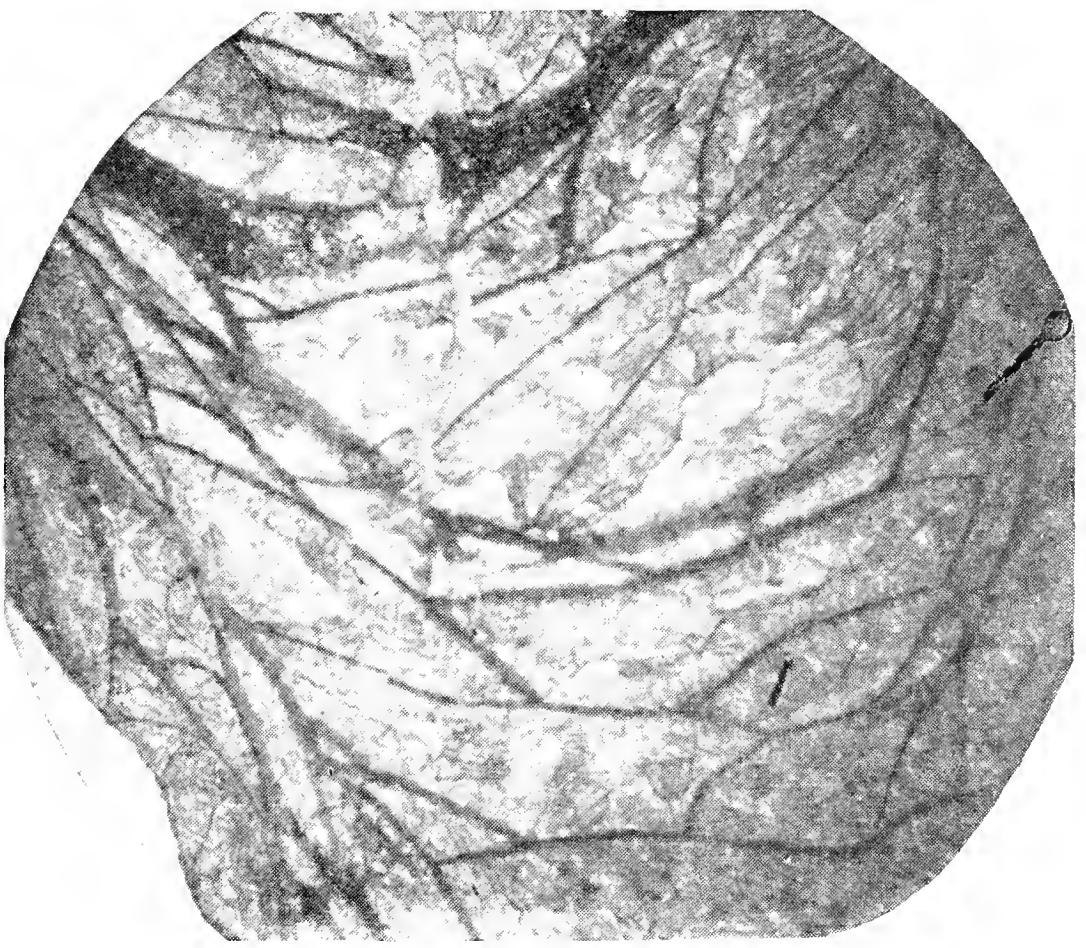


Fig. 11. ×7

F.C., photo.

FAVOSITES, GOTHLANDICA, LAM. AND RHIZOPHYLLUM ENORME. ETH. FIL.

Plate XXI.

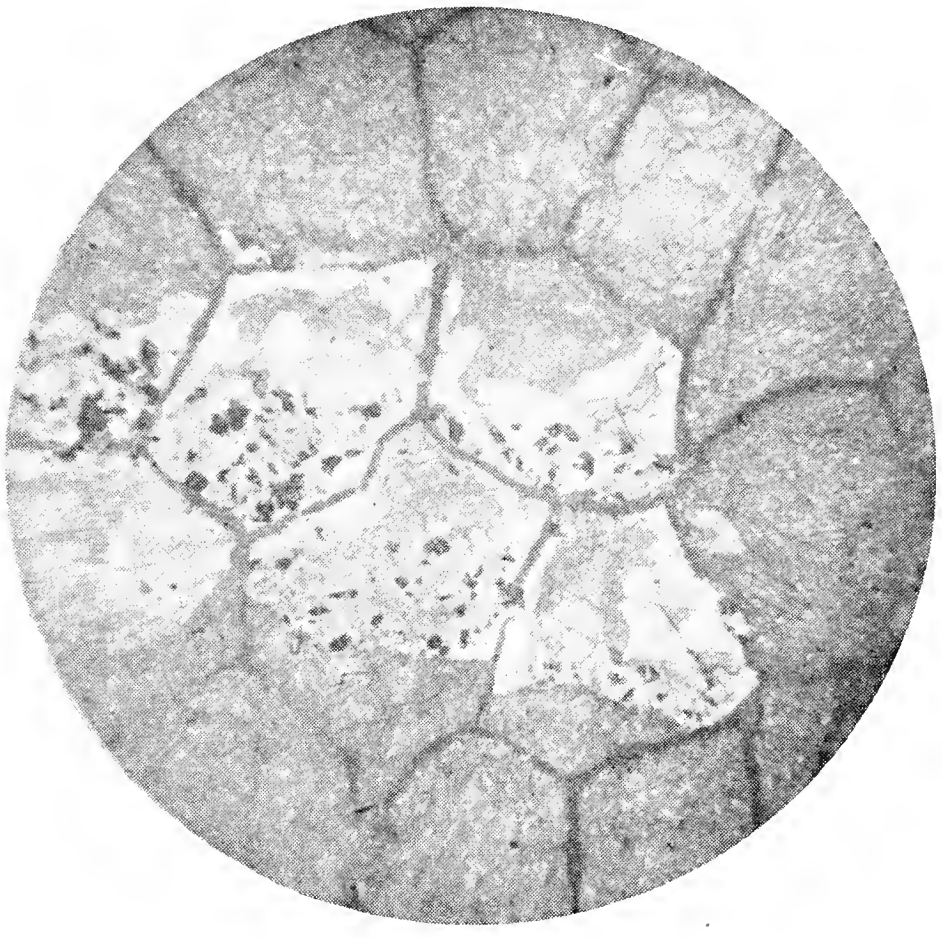


Fig. 12. ×13

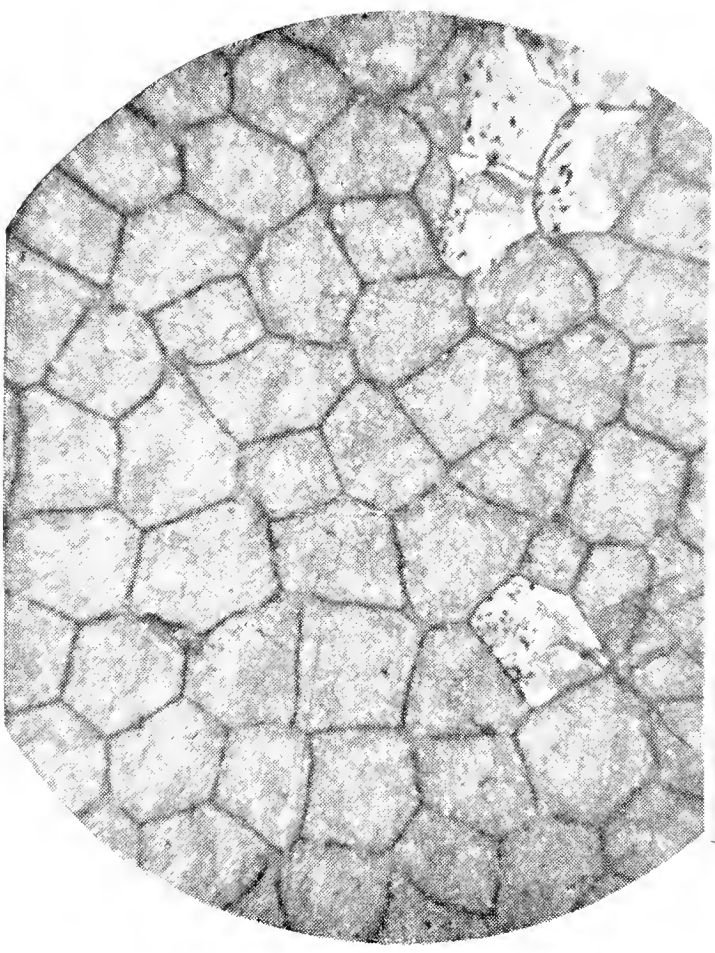


Fig. 13. ×7

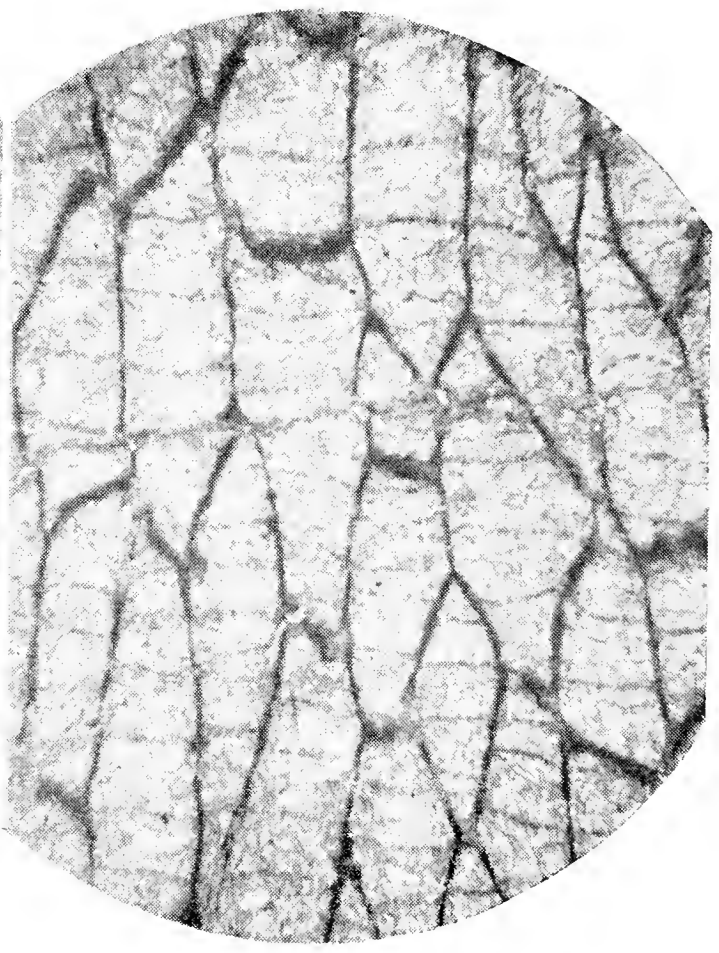


Fig. 14. ×7

F.C., photo.

FAVOSITES GOTHLANDICA, LAMARCK.

Plate XXII.

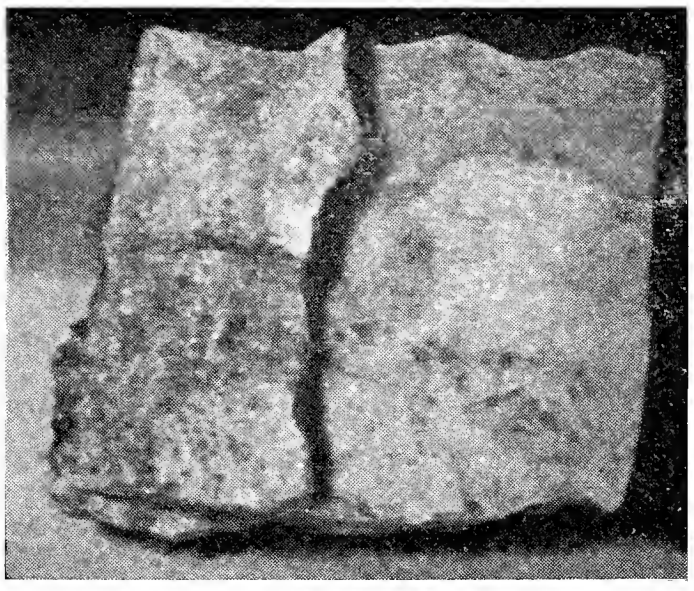


Fig. 15. Nat. size.

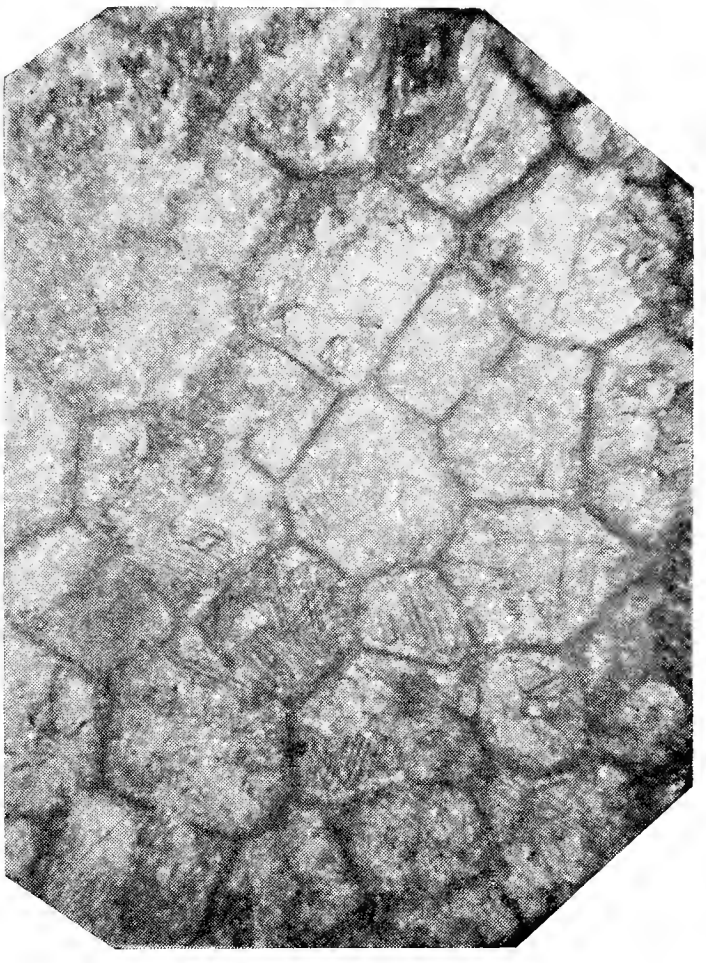


Fig. 16. ×13

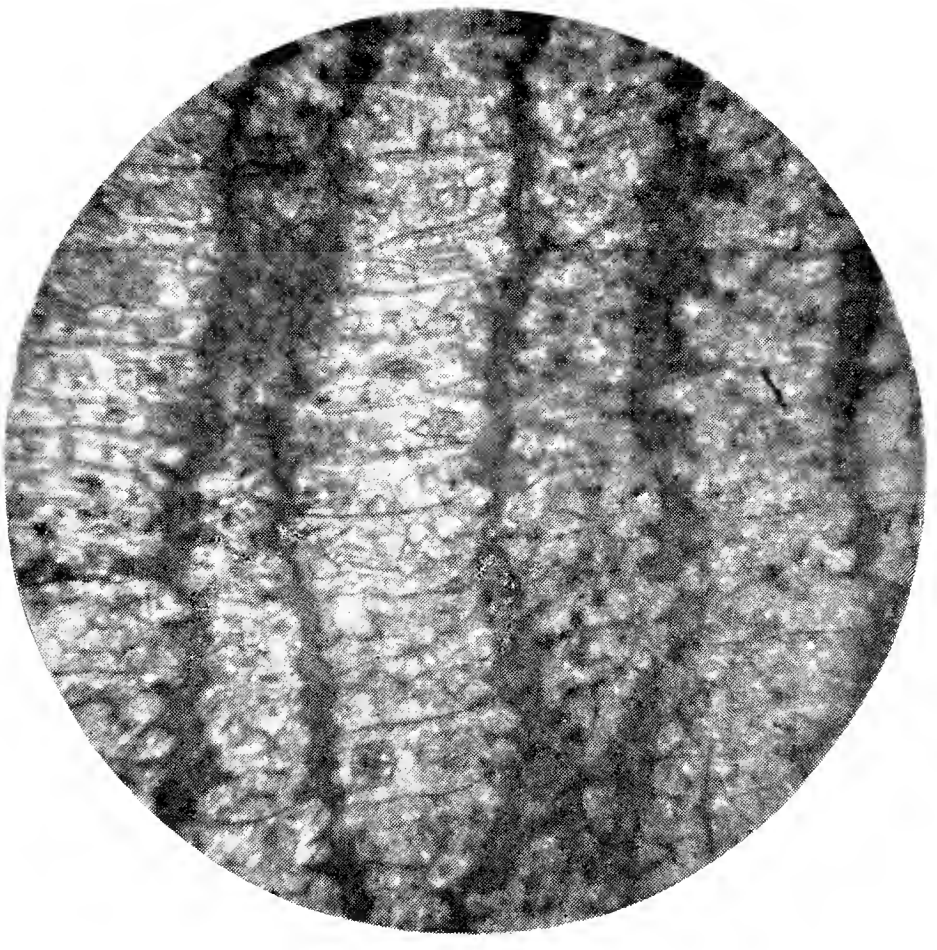


Fig. 17. ×13

F.C., photo.

FAVOSITES BASALTICA, GOLDFUSS, VAR. MOONBIENSIS, ETH. FIL. AND F. FORBESI, EDWARDS AND HAIME.

Plate XXIII.

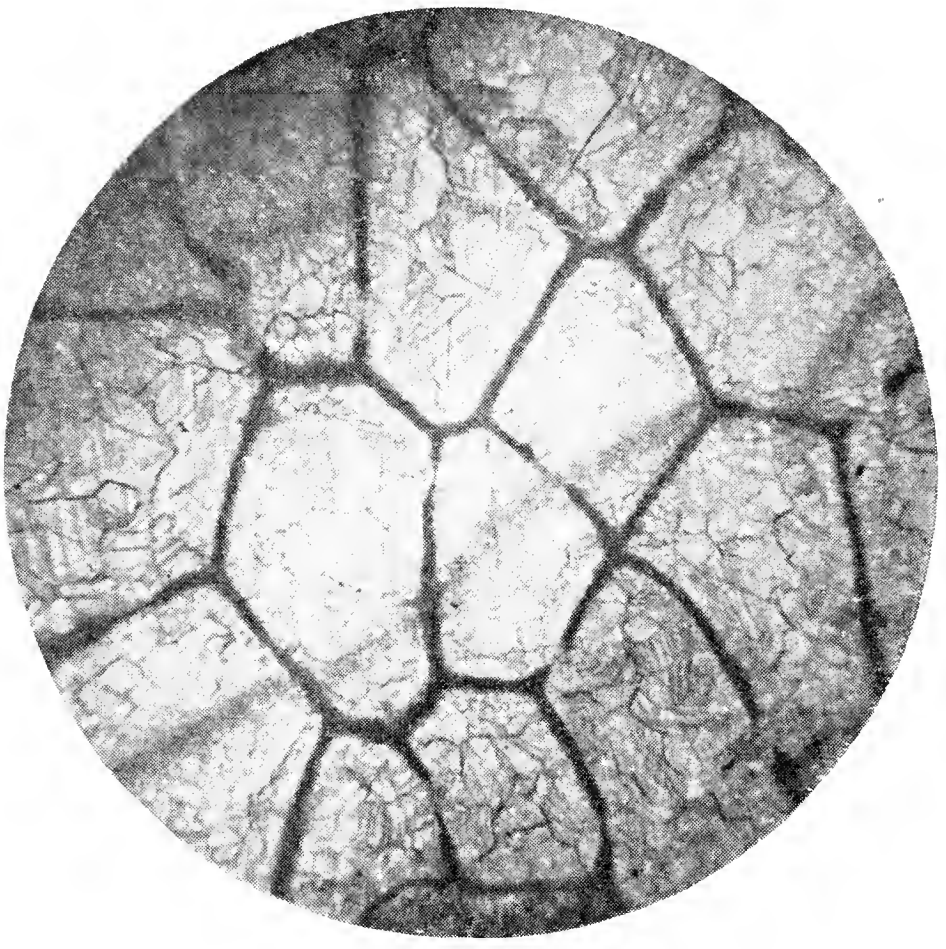


Fig. 18. ×13

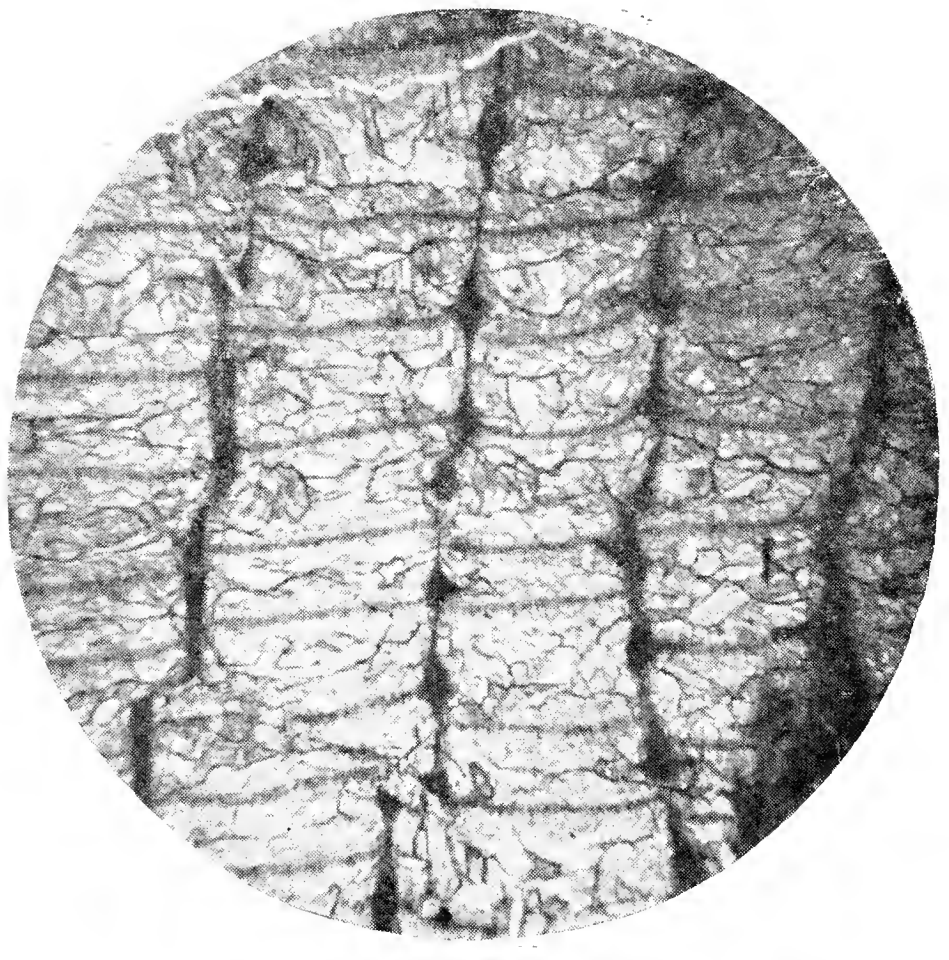


Fig. 19. ×13

F.C., photo.

FAVOSITES GOTHLANDICA, LAMARCK.

Plate XXIV.

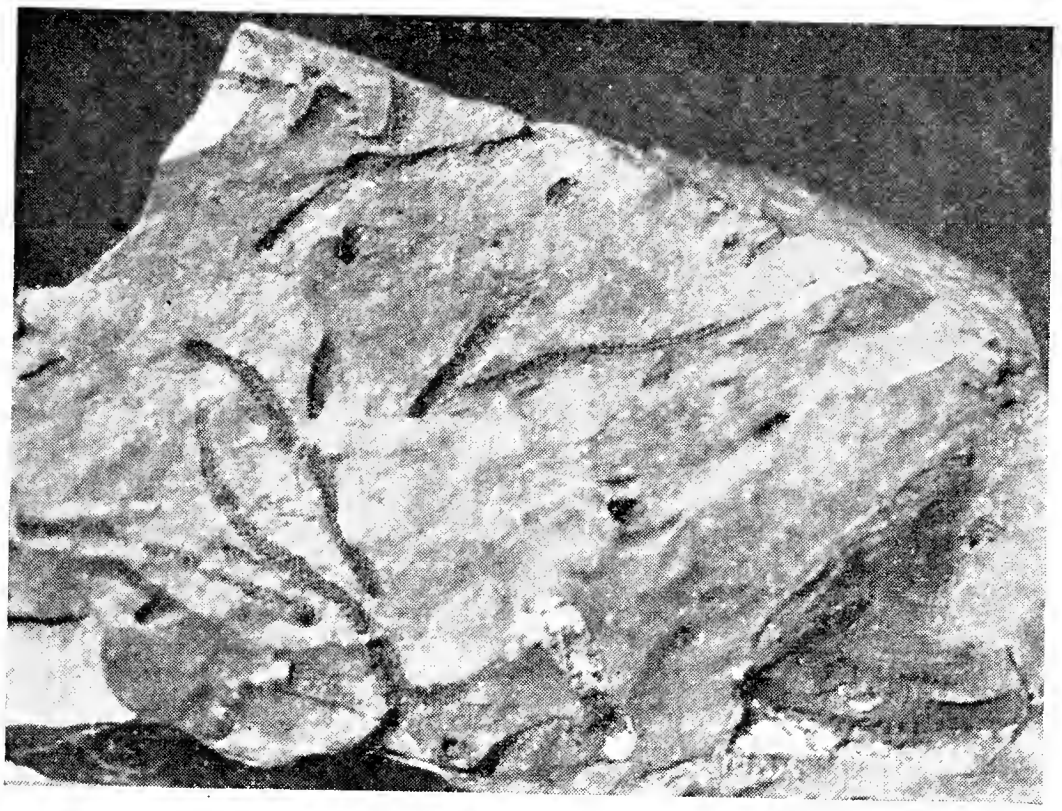
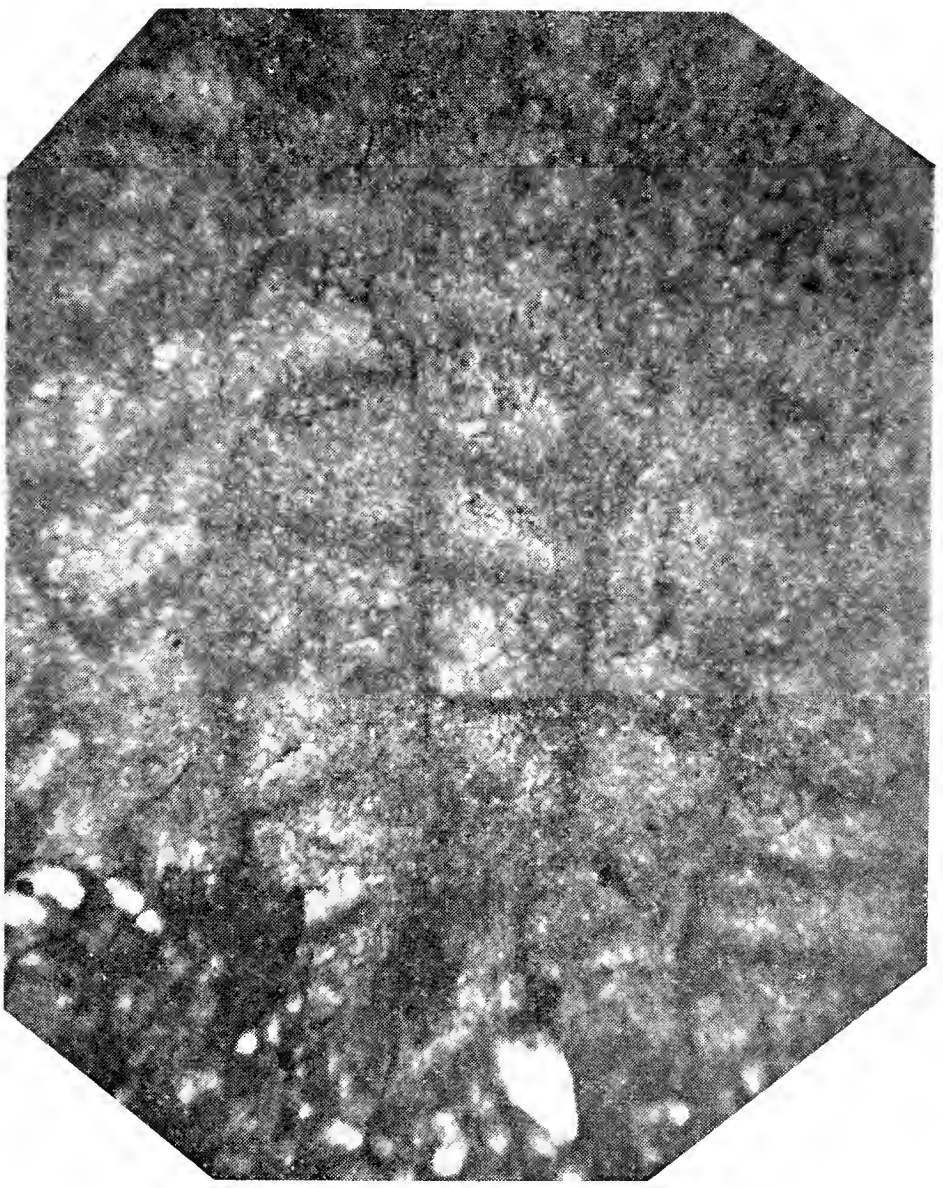


Fig. 20. Nat. size.



F.C., photo.

Fig. 21. ×13

ACANTHOCLEMA FLEXUOSUM, CHAPM. AND FAVOSITES BASALTICA, GOLDF. VAR. MOONBIENSIS, ETH. FIL.

Plate XXV.

Fig. 22. ×13

Fig. 23. ×13

F.C., photo.

HALYSITES ORTHOPTEROIDES, ETH. FIL.

PLATE XXVI.

FIG. 24. ×13

FIG. 25. ×13

F.C., photo.

HALYSITES CF. ORTHOPTEROIDES, ETH. FIL. AND H. PYCNOBLASTOIDES, ETH. FIL.

Plate XXVII.

Fig. 26. ×13

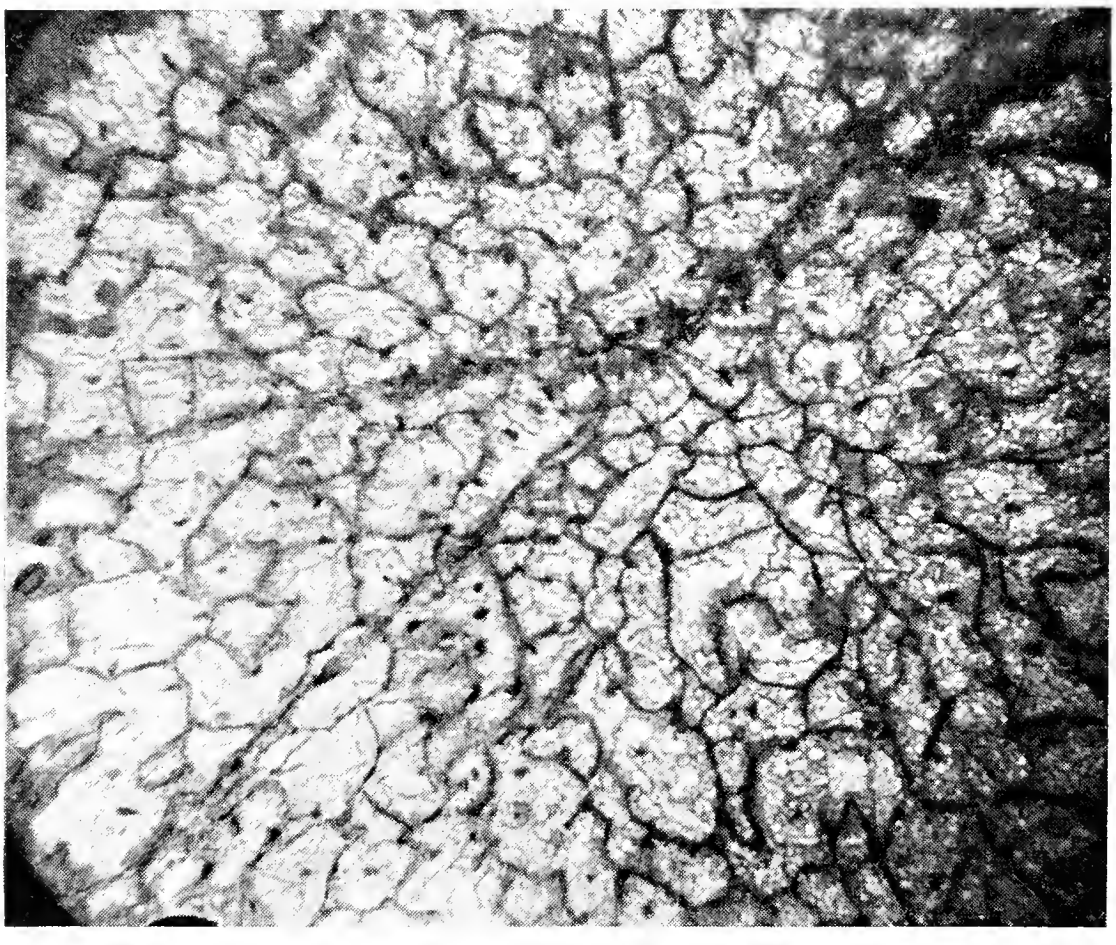


Fig. 27. ×7

F.C., photo.

FISTULIPORA COWOMBATENSIS, CHAPMAN.

Plate XXVIII.

Fig. 28. ×7

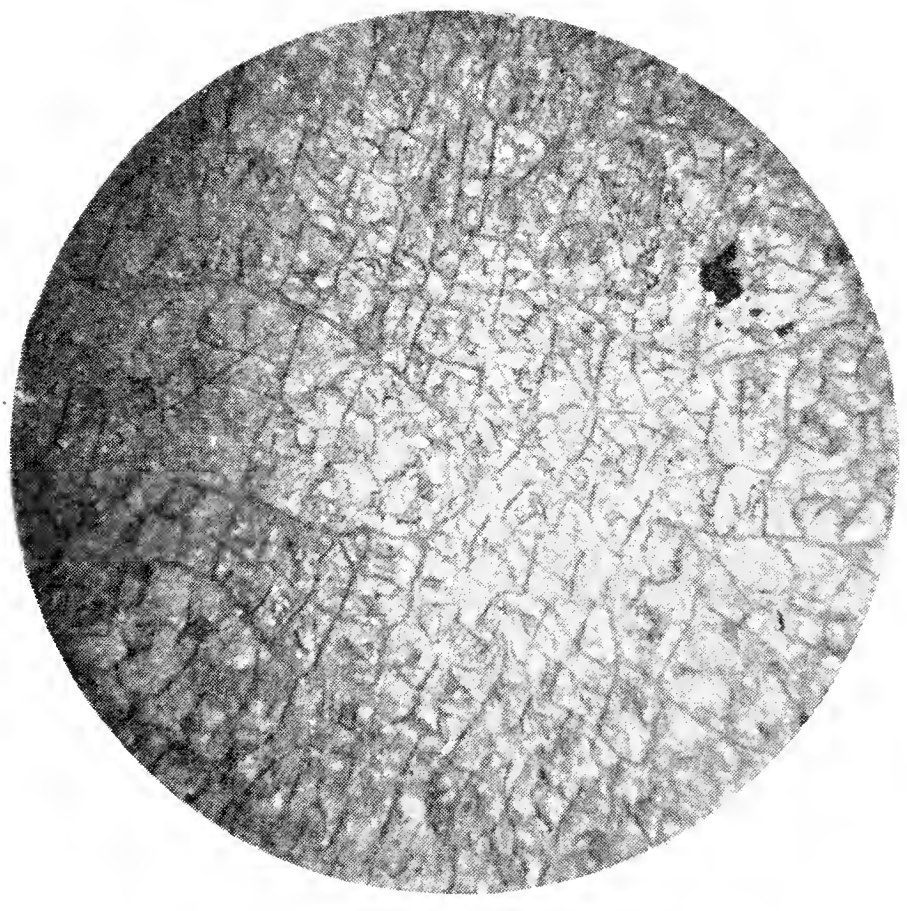


Fig. 29. ×13

F.C., photo.

PLASMOPORA AUSTRALIS, ETH. FIL. AND HELIOLITES INTERSTINCTA, L., VAR. GIPPSLANDICA, CHAPM.

Plate XXIX.

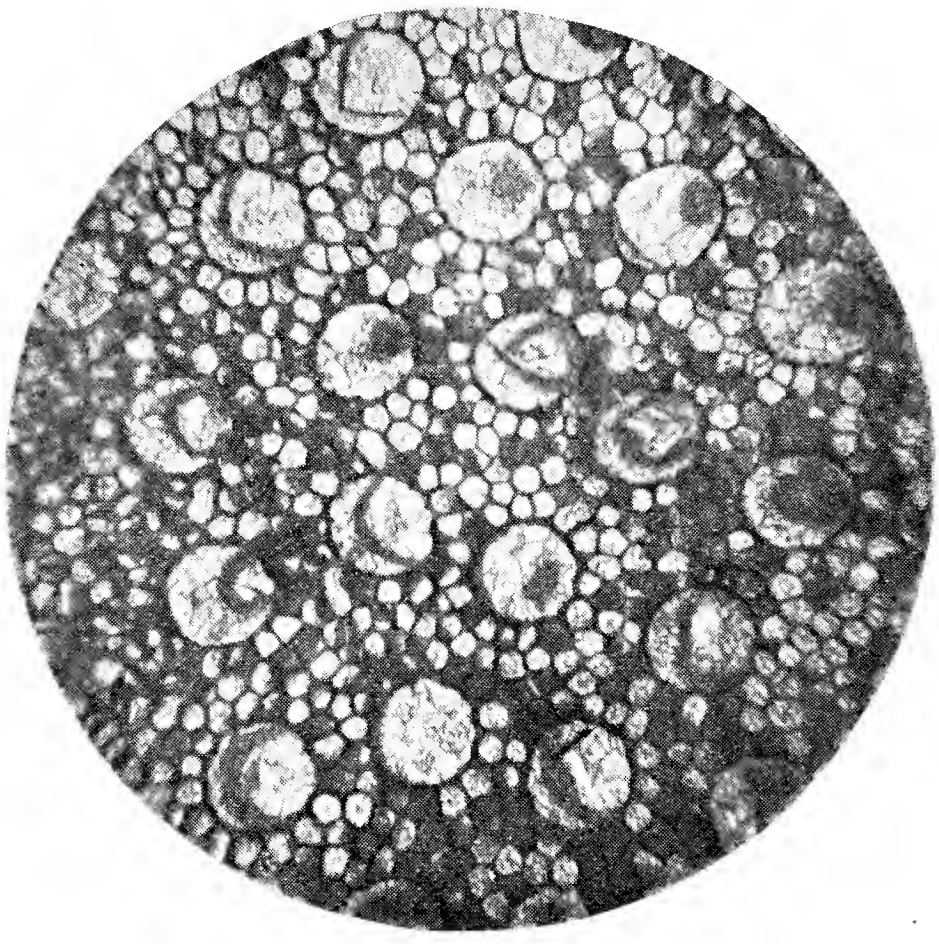


Fig. 30. ×7

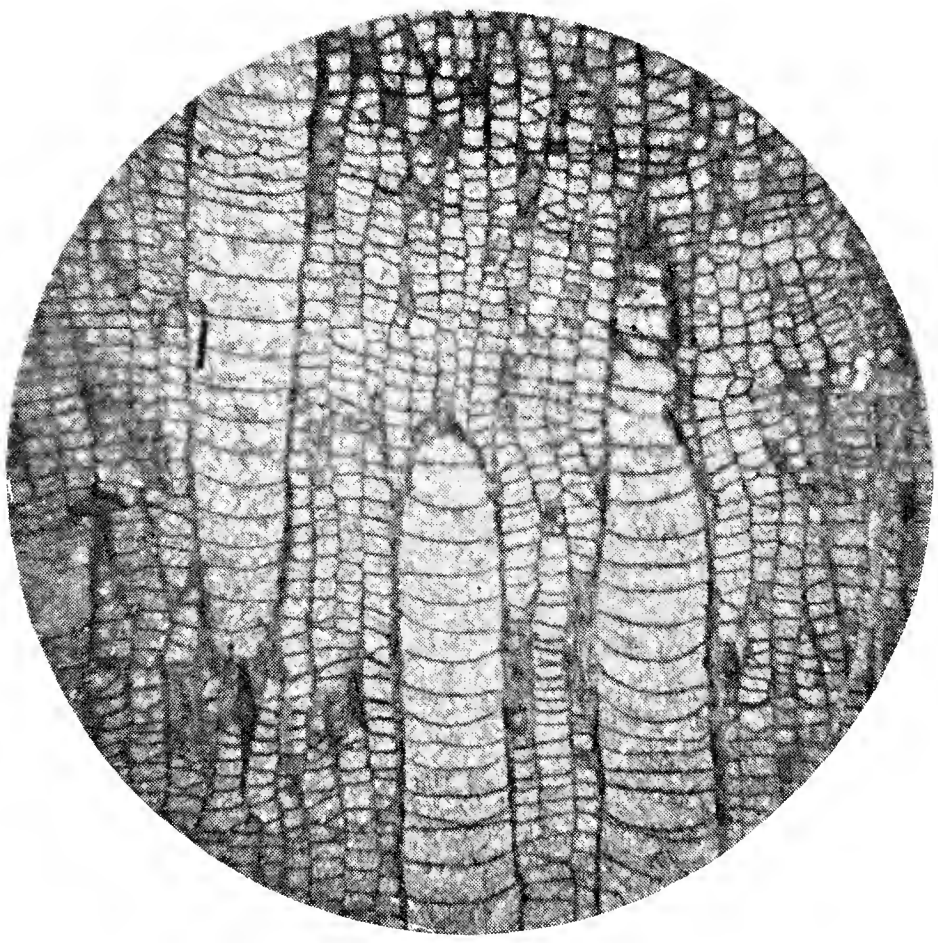


Fig. 31. ×7

F.C., photo.

HELIOLITES INTERSTINCTA, L. VAR. GIPPSLANDICA, CHAPM.

Plate XXX.

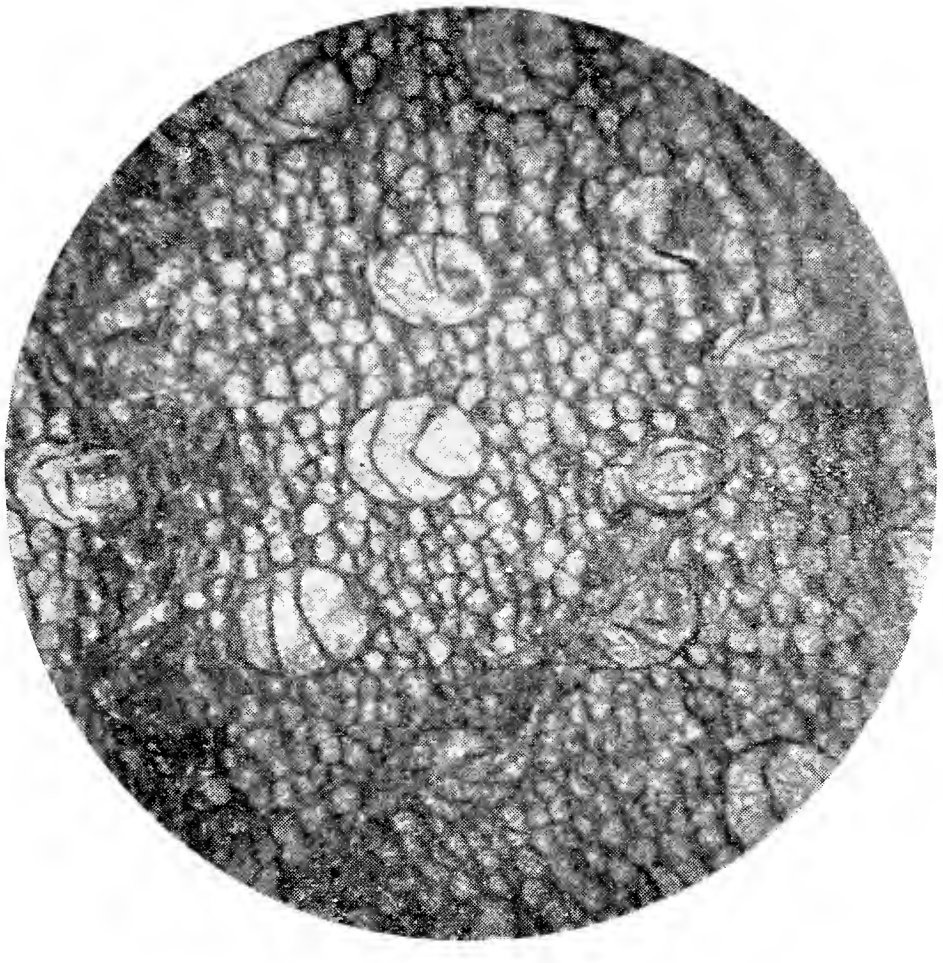


Fig. 32. ×7

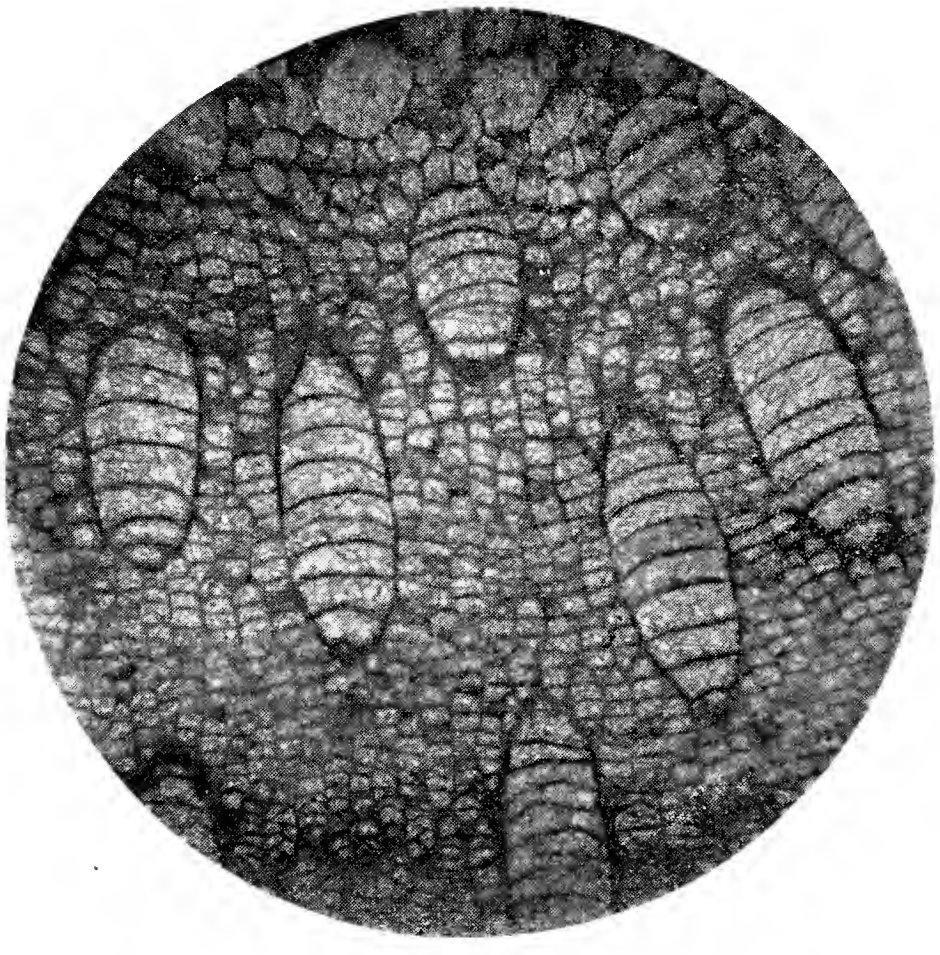


Fig. 33. ×7

F.C., photo.

HELIOLITES INTERSTINCTA, L. VAR. GIPPSLANDICA, CHAPM.

Plate XXXI.

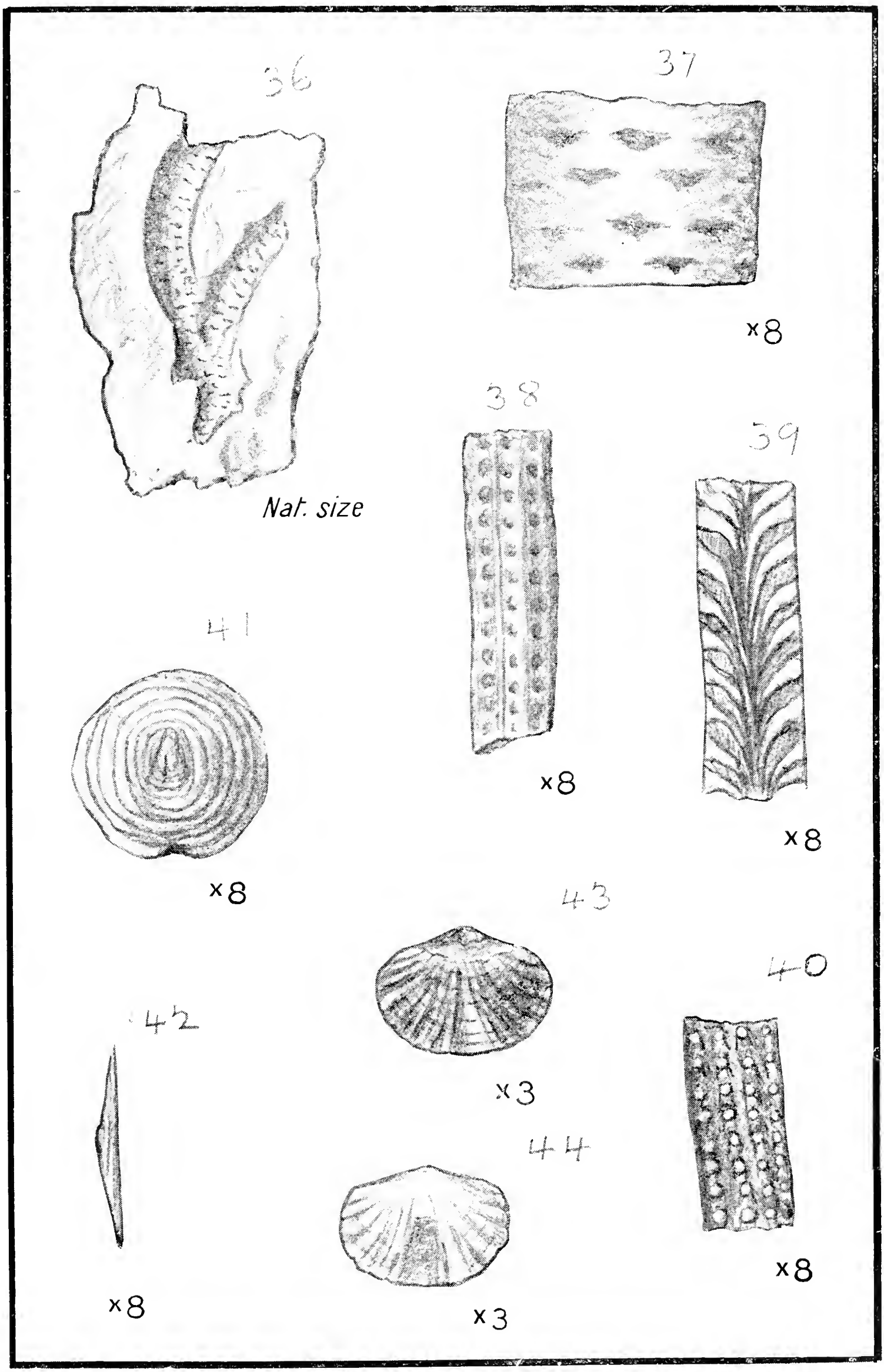
Fig. 34. ×13

Fig. 35. ×13

F.C., photo.

OSTRACODAL AND SHEARED LIMESTONES.

Plate XXXII.



F.C., ad nat. del.

NEW YERINGIAN FOSSILS, N.E. GIPPSLAND.

VICTORIAN GRAPTOLITES.

SOME SUBZONAL FORMS OF THE LOWER BENDIGO AND UPPER LANCEFIELD ZONES.

By R. A. Keble, Assistant Field Geologist.

Since Nicholson published his description of *Tetragraptus approximatus* in 1873[1] its origin, characteristics and affinities have never been discussed; in fact, outside of the graptolite shales of Victoria it appears to be a comparatively rare form, and, apart from the citations of its occurrence at Point Levis[2] and Arkansas[3], the writer is aware of no others. First discovered in Victoria by W. H. Ferguson at Dromana, and recognised by the late Dr. T. S. Hall from there and many other localities, its constant recurrence, characteristic symmetry and range in regard to the well-authenticated Lancefield and Bendigo zones, invest it with importance as a subzonal species. Nicholson's wood-cuts show few of the thecal characteristics, and his description was formulated at a time when the stipes of the first order ("funicle") were considered to be destitute of thecæ. In view of the light thrown on the genus Tetragraptus by recent research and the inaccessibility of Nicholson's paper, it has been thought advisable to describe the Victorian form and compare it with the original description, particularly as it is likely to play a prominent part in the imminent subzoning of the Bendigo and Lancefield zones.

Genus **Tetragraptus,** Salter.

RECUMBENT DEPENDENT SERIES.

Tetragraptus approximatus, Nicholson, Ann. and Mag. of Nat. His. 4th Ser. Vol. XI. (1873), p. 136, fig. (Plate XXXIII., Fig. 1a—c.)

Tetragraptus approximatus, Gurley, Arkansas Geol. Surv. Ann. Rept., 1890.

Tetragraptus approximatus, T. S. Hall, Reports on Graptolites from Balnarring and Bull-Dog Creek, near Dromana. Rec. Geol. Surv. Vict., vol. I., pt. 3, pp. 220-1.

Tetragraptus approximatus, T. S. Hall, Report on Graptolites from Hustler's Line of Reef, vol. I., pt. 4, p. 273.

Tetragraptus approximatus, T. S. Hall, Reports on Graptolites at Inglewood. Rec. Geol. Surv. Vict., vol. III., pt. 2, pp. 195-6 (viz., 4032, 4020, 3985, 3939).

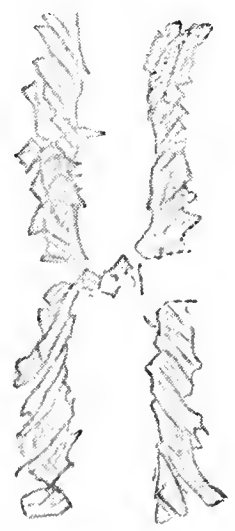


Fig. 61.—TETRAGRAPTUS APPROXIMATUS, NICHOLSON.

Showing general aspect of polypary. Reverse view ×3¼. Bull Dog Creek, near Dromana. Collected by W. H. Ferguson, Geol. Surv. Coll., No. 285.

Description.—The sicula (or as much as may be seen) is about 1.1 mm. long, and has an inconspicuous nema. The first and second thecæ appear to originate near the apex of the sicula and develop in opposite directions, initiating the stipes of the first order. The dichotomous division resulting in stipes of the second order takes place within the third and fourth thecæ. The total length of the stipes of the first order is 2.5 mm. The stipes of the second order are slender (.5 mm.) at their commencement, but widen out in 4 mm. to 2 mm., and maintain that width throughout.

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[1] Ann. and Mag. of Nat. His. 4th Ser. Vol. XI. (1873), p. 136.

[2] Ibid.

[3] Gurley, R. R. The Geologic Age of the Graptolite Shales of Arkansas. Arkansas Geol. Surv. Ann. Rept. 1890.

Thecæ 11 in 10 mm., submucronate, slightly curved, inclined to the axis of the stipe at an angle of between 35° and 40°, three times as long as wide, in contact for two-thirds of their length. Apertural margin, slightly concave, almost normal to the axis of the thecæ (forming an angle of 115° with the axis of the stipe). Main stipes (second order) have an observed length of 25 mm., but probably are much longer, are straight and rigid and of uniform width from about 4 mm. from the bifurcation to their distal extremities. Lying at right angles on opposite sides of the stipes of the first order ("funicle") each pair of opposite stipes are in the same straight line, imparting to the polypary its characteristic H symmetry.

Remarks.—Nicholson's original description[1] was as follows:—"Frond consisting of four simple undivided stipes, arranged bilaterally, two proceeding from each extermity of the funicle. Regarding the funicle as horizontal, the stipes are as nearly as possible at right angles to it; so that the two stipes on either side of the funicle form nearly a straight line. Stipes curved at their origin from the funicle, and then running nearly straight and parallel to one another. The entire form closely resembles two examples of *Didymograpsus (Graptolithus) patulus*, Hall, united back to back by their radicles. Dimensions of the frond in the largest specimen observed:—Length of funicle, one-tenth of an inch; width of funicle, one-twentieth of an inch; total length of frond unknown, but exceeding $3\frac{1}{2}$ inches; distances between the stipes opposite sides of the frond from one-fifth to one-fourth of an inch, except close to the funicle. Cellules about twenty-five in the space of 1 inch, inclined to the axis at about 45°; the denticles prominent and slightly pointed or submucronate; the cell-mouths curved at right angles, or nearly so, to the cellules, and making an angle of about 135° with the axis."

The following is a comparative tabulation of the specific characters of the type species and that from Victoria:—

——	Nicholson.	Victorian Species.
Thecæ in 10 mm.	10–11	11
Angle of inclination—		
,, distal thecae	45°	38°
,, proximal thecæ (approximate) ...	20°–30°	20°
Overlap	$\frac{1}{2}$–$\frac{2}{3}$	$\frac{1}{2}$–$\frac{2}{3}$
Apertural margin	submucronate slightly concave	submucronate slightly concave
Angle (average) of apertural margin to axis of stipe	112°	103°
Maximum observed length of stipe ...	88 mm.	25 mm.
Width of main stipes distally	about 2 mm.	2 mm.
Width of main stipe proximally ...	about ·6	·6
Ventral margin	slightly concave	concave
Length of stipe of first order (funicle) ...	2·6	2·3
Width of stipe of first order	1·3	1·1

Affinities.—*T. approximatus* is more nearly related to *T. acclinans* sp. nov. (p. 198 *post*) than to any other species yet described from Victoria or elsewhere; the essential differences are treated on when con-

[1] Ann. and Mag. of Nat. His. 4th Ser. Vol. XI. (1873), p. 136.

sidering that species. The young forms of *T. approximatus* and *T. serra* (in a peculiar state of preservation) are often difficult to separate *T. serra*, however, being a reclined form, its sicula is usually conspicuous and its main stipes are so preserved that they show no tendency to become parallel.

Horizon.—Lower Ordovician and Upper Cambrian.

The following table represents its approximate vertical range:—

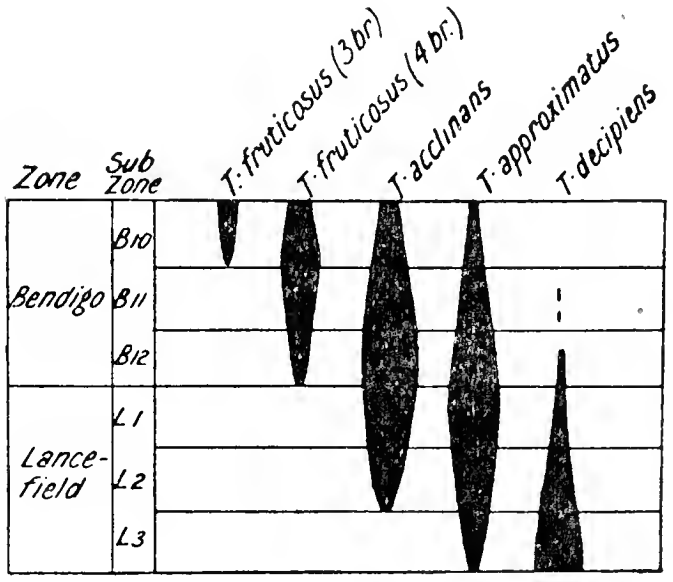

FIG. 62.—Synoptic table, showing range of *T. fruticosus* (zone index), *T. acclinans*, *T. approximatus*, and *T. decipiens*.

Other associates in the Bendigo zone are *T. clarkei*, *T. serra*, *T. quadribrachiatus*, *T. bryonoides*, *T. similis*, *T. pendens*, *T. harti*, *C. rigidus* var. *tenellus*, *C. magnificus*, *D. extensus*, *D. dilatans*, *D. latus*, *G. thureaui* (?), *G. macer* (?), *P. cf, typus*, *D. octobrachiatus*, which are typical of the Lower Ordovician. Its association in the Lancefield zone is restricted to a few species including *T. decipiens*, *C. rigidus*, var. *tenellus*, *Didymograptus ssp.* and *Bryograptus ssp.*, an association so far only found in Victoria. Below it in the lower part of the Lancefield zone the genera *Bryograptus*, *Clonograptus* and *Dictyonema* all reach the height of their development and are represented by a few isolated species in the upper part of the Lancfield and lower part of the Bendigo zone. About subzone L2 of the Lancefield zone a noticeable change in the character of the thecæ occurs, namely, from an excess of Bryograptid and Clonograptid types to the typical Tetragraptid and Didymograptid types of the Lower Ordovician. The writer has for many years considered that the greater part of the Lancefield zone is at the summit of the Upper Cambrian, and anticipated the finding of such an association as is represented by subzone 2 of the Lancefield zone[1].

T. approximatus has been found at Dromana, Inglewood, Balnarring, Bendigo (several localities), Newstead, Boolara, &c., &c.

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[1] Mr. F. Chapman, Hon. Palæontologist to the Geo. Sur. of Victoria, permits me to state that he has identified typical Upper Cambrian crustacea from the Mansfield chert and phosphate beds. *Vide* "Phosphate Deposits at Mansfield," by A. M. Howitt, and note on Tetragraptus approximatus and T. decipiens, Bull 42, Geol. Surv. Vict. (M.S.).

TETRAGRAPTUS ACCLINANS sp. nov. (Plate XXXIII., Fig. 2A-C).

Tetragraptus approximatus, T. S. Hall, Reports on Graptolites. Rec. Geol. Sur., Vic., vol. III., pt. 2, p. 188.

Tetragraptus approximatus, Ibid. p. 195 (viz., 4012, 3989, 3999, 4039).

A recumbent form of Tetragraptus with sufficient characteristics to merit specific rank, and likely to be of some value in subzoning the Bendigo and Lancefield zones, is *T. acclinans* sp. nov. This type specimen was collected by E. O. Teale.

FIG. 63.—TETRAGRAPTUS ACCLINANS SP. NOV.

Showing general aspect of polypary of young specimen; reverse view ×3¼ Lightning Hill anticline, east of Great Extended Hustlers Mine, Bendigo, collected by E. O. Teale, Geo. Sur. Coll. No. 2763.

Description.—Portion of the sicula visible is about 1 mm. long, but owing to the method of compression this dimension is no criterion as to actual length. The first and second thecæ apparently originate near the apex of the sicula, and develop in opposite directions, forming two stipes of the first order about 3 mm. long. About 1 mm. wide near their origin, the stipes of the second order gradually widen distally to 2 mm. or more, and gently curve for about 12 mm., when they become rigid and are normally disposed at an angle of 90° to the stipes of the first order. The longest stipes observed measured 40 mm. Thecæ eight or nine in 10 mm., mucronate, about four times as long as wide in contact for about half their length, normally inclined at an angle of about 40°, but, according to the mode of preservation, varying from between 35° and 52°. Apertural margin concave at an angle of 90° to the axis of the stipe; ventral margin slightly concave.

Remarks.—The proximal thecæ of the stipes of the second order are rarely seen owing, no doubt, to the original position of the stipes and the downward direction of the thecæ. On compression, these stipes are twisted either to one side or the other, a fact attested by neighbouring and parallel stipes in some specimens (Plate XXXIII., Fig. 2A) being preserved with their thecal apertures facing in the one direction. In other specimens (Fig. 63) the ventral margin of the proximal thecæ become at first indistinctly visible, and are disposed at an abnormal angle to the axis of the stipe, but further away, display a tendency to assume normality, showing that the proximal thecæ are embedded, but through twisting of the stipe the distal ones lie on their lateral walls.

Due both to the form of the polypary (particularly to the position of the sicula and the widening of the main stipes and the mode of compression) the main stipes on the sicula side of the stipes of the first order ultimately assume a parallel position at an angle of approximately 90°, while those on the opposite side are divergent and disposed at an angle above 100°. There seems to be little doubt that 90° is about the normal position of the main stipes.

Affinities.—*T. acclinans* differs from *T. approximatus* in several respects; of these, the important differences are:—

(*a*) The gradual widening of the stipes of the first-named compared to rapid widening of the second.

(*b*) The gentle intral curvature of the main stipes of the first-named compared to the rapid, strong curvature of the second.

(*c*) The absence of that parallelism in the first-named is characteristic in the second, which, although not constant and depending on the mode of preservation, is evidence of essential differences in the two forms.

Young species of *T. acclinans* bear certain resemblances to *T. quadribrachiatius*. The conditions of growth of both species are not unlike, but they will readily be separated by the thecal differences and the disposition of the main stipes.

Associates—

T. acclinans is found with *T. approximatus*.

T. decipiens, Clonograptus rigidus var. *tenellus, T. fruticosus, &c.*

Its associates are practically those of *T. approximatus*.

Horizon and Localities—

Lower Ordovician, Upper Cambrian.

It is thought that *T. acclinans* will be found to be a slightly younger form than *T. approximatus*, and will, therefore, have some value as a subzonal form[1].

The localities at which this species has been found are Hustler's Hill, One Tree Hill syncline (Valentine-street), Bendigo, Boolara, Newstead, &c.

RECLINED SERIES.

TETRAGRAPTUS DECIPIENS, T. S. Hall (Plate XXXIV., Fig. 1A-E).

The late Dr. Hall, as far back as 1898, described[2] *Tetragraptus decipiens*, and figured in outline its polypary. The writer had lately found the horizon where this species attains the maximum of its development—in other words, the typical *T. decipiens* subzone (L3) of the Lancefield zone. It occurs about 800 feet below the base of the Bendigo zone (actual thickness of beds), and is typically developed on the Flag anticline where it is crossed by Valentine-street, Bendigo, immediately opposite the Central Bendigo Mine.

In view of the importance of this species in subzoning the upper part of the Lancefield, and possibly the lower part of the Bendigo zones, it has been considered advisable to amplify the description with additional information to hand and re-figure it.

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[1] *Vide* p. 197, *ante*.
[2] T. S. Hall, Proc. Roy. Soc. Vict. XI., 1899, p. 168.

Tetragraptus quadribrachiatus, Pritchard (non J. Hall), Proc. Roy. Soc. Vict., N.S. VII., 1895, p. 30.

Tetragraptus decipiens, T. S. Hall, The Graptolites of the Lancefield Beds, Victorian Graptolites, pt. II., ibid XI., 1899, p. 168, pl. XVII. & XVIII.

Tetragraptus decipiens, T. S. Hall, Reports on Graptolites. Rec. Geol. Surv. Vict., vol. II., pt. I., pp. 2 & 3; vol. III., pt. 2, pp. 191-7, 199-200, 202-4, 206-7.

FIG. 64.—TETRAGRAPTUS DECIPIENS, T. S. Hall.

Obverse aspect of polypary showing nema ×3¼. Geol. Surv. Coll. No. 240.

Description.—The longest nema (virgula) observed, about 5 mm. in length, is thin and filiform. Sicula, rarely seen in toto, about 2·3 mm. long. The first thecæ apparently originates within apical third of sicula, and the first two thecæ on each side of the sicula form the stipe of the first order, which, together are from 2·5 to 3·5 mm. long and 7 mm. wide.

Stipes of the second order are approximately straight, of an observed length of over 35 mm., but probably longer, gradually widening from .6 mm. proximally to 1.5 mm. distally. In some specimens a thickening of the dorsal wall of the cœnosarcal canal is evident (pl. XXXIV., fig. 1A).

Thecæ 9 to 11 in 10 m., narrow, from four to six times as long as wide, slightly curved, inclined about 34° proximally and 27° distally, overlapping for about half their length. Apertural margins of proximal thecæ about normal to the direction of the stripe, straight or slightly concave; those of distal thecæ normal to axis of thecæ, concave.

Remarks.—Dr. Hall's original description[1] was as follows:—"From stout branches arising close to the sicula, apparently from the second and third thecæ and from 0.5 to 1 mm. broad. Thecæ slightly expanding, overlapping for about one-half their length; apertural margin concave, set at an angle of 95° to 100° to axis of branch; on the margin with a slight concave curvature which gently increases near the aperture; inclined first at an angle of 10° to the branch and near the aperture of about 30°. Virgula shown as a fine line, often about 7 mm. in length."

Affinities.—*T. decipiens* is undoubtedly allied to *T. quadribrachiatus*, but is probably more closely related to *Clonograptus*, the common ancestor of the *Dichograptids*. The simple tubular thecæ of *T. decipiens* are illustrated by pl. XXXIV., fig. 1A, and are more suggestive of *Clonograptus* than *T. quadribrachiatus*.

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[1] T. S. Hall. Proc. Roy. Soc. Vict. XI., 1899.

The following table of some of the specific characters of the two forms *T. decipiens* and *T. quadribrachiatus* is interesting: —

Character of Stipes.	*T. decipiens.*	*T. quadribrachiatus.*
	Reclined straight.	Horizontal straight.
Maximum width of stipes (2nd order) ..	1·5	2·6
Width of stipes (1st order)	1·3	·6
Length of stipes (1st order)	3·0	2·6
Length of sicula	2·3	—
Length of nema	5·0	—
Number of thecæ in 10 mm.	11-9	10–9
Inclination	27°–34°	30°–40°
Overlap	$\frac{1}{2}$–$\frac{2}{3}$	$\frac{1}{2}$–$\frac{2}{3}$
Dimensions (length to width)	4–6 times	4 times

"The presence of the prolonged virgula (nema), the much narrower thecæ, and their smaller angle of inclination to the axis of the branch," states Dr. T. S. Hall[1], "sufficiently distinguishes this species from *T. quadribrachiatus.*"

The essential morphological difference, however, is in the stipes being slightly reclined in *T. decipiens* and horizontal in *T. quadribrachiatus.* That this is so is exemplified by fig. 64, an obverse aspect which would be otherwise impossible, also by other figures, especially that of a specimen (pl. XXXIV., fig. 1A) collected by W. H. Ferguson from Boolara, in which the thecæ are preserved in relief.

Horizon and Localities.—Lower Ordovician and Upper Cambrian.

The upper extent of its range is approximately equivalent to that of *T. approximatus* (*vide* p. 197 *ante*), but it appears much earlier than that species. At Lancefield, W. J. Harris and the writer have found it associated very sparingly with *Bryograptus victoriæ* in beds which the later considers about the maximum development of the last-mentioned form. In this association only three identifiable forms were found, namely, *B. victoriæ* (very common), *Clonograptus sp.* (rare), *T. decipiens* (rare). At the type locality Dr. T. S. Hall[3] records *Bryograptus victoriæ, B. clarki, Leptograptus antiquus, Didymograptus pritchardi, D. taylori, Clonograptus flexilis, C. magnificus, C. rigidus, C. rigidus* var. *tenellus, Dictyonema macgillivrayi* and *D. pulchellum.* It would seem that this association is younger than that from the first-named locality, an inference somewhat supported by the stratigraphy of the locality. For other associations the reader is referred to the numerous reports on graptolites published in the Records of the Geological Survey of Victoria. *T. decipiens* has been found at Lancefield, Mornington, Boolara, Bromley, Tarnagulla, Llanelly, Inglewood, Eganstown, Wombat, Rock Lead, Dean, Barkstead, Bullarook, Clarendon, Elaine, Mansfield, &c., &c.

[1] T. S. Hall, Proc. Roy. Soc. Vict. XI. 1899.
[2] Ibid, p. 168.
[3] Ibid, p. 175.

EXPLANATION OF PLATES.

XXXIII.

GENUS. **Tetragraptus.** Salter.

1A-C.—*Tetragraptus approximatus,* Nicholson.

1A.—Fairly well preserved specimen showing distal thecæ (plesiotype) x 2. Reverse view, Lancefield zone (L1). Collected by W. H. Ferguson, Geol. Surv. Collection 18594.

1B.—Specimen indifferently preserved but showing parallelism of stipes and symmetry of polypary (plesiotype) x 2. Reverse view, Bald Hill Quarry, Dromana, Bendigo zone. Collected by W. H. Ferguson, Geol. Surv. Collection 1167.

1C.—Distorted specimen (plesiotype) x 2. Reverse view, One Tree Hill Syncline, Bendigo, Lancefield zone (L1). Collected by R. A. Keble, Geol. Surv. Collection .

2A-C.—*Tetragraptus acclinans*, sp. nov.

2A.—Large specimen (holotype) indifferently preserved but showing general aspect of polypary x $2\frac{1}{2}$. Reverse view, Lightning Hill Anticline, east of Great Extended Hustler's Mine, Bendigo. Collected by E. O. Teale, Geol. Surv. Collection No. 2763.

2B.—Specimen with three stipes compressed with thecæ downwards (paratype) x 2. Hustler's Hill, Bendigo, Lancefield zone (L1). Collected by R. A. Keble, Geol. Surv. Collection .

2C.—Two opposite stipes only preserved, presenting the aspect of Didymograptus (paratype) x 2. Flag Syncline, Valentine-street, Bendigo, Lancefield zone (L2). Collected by R. A. Keble, Geol. Surv. Collection .

XXXIV.

1A-E.—*Tetragraptus decipiens*, T. S. Hall.

1A. Polypary preserved in relief showing distal thecæ and cœnosarcal canal (plesiotype) x 2. Reverse aspect. Boolara-Lancefield zone (L1). Collected by W. H. Ferguson, Geol. Surv. Collection No. 18609.

1B.—Large polypary (plesiotype) x 2. Reverse aspect. Lancefield, Lancefield (Lower) zone. Geol. Surv. Collection No. 34.

1C.—Common appearance of polypary (plesiotype) x 2. Reverse aspect. Lancefield, Lancefield (Lower) zone. Geol. Surv. Collection No. 238.

1D.—Reverse aspect showing different modes of preservation of stipes in single specimen (plesiotype) x 2. Boolara, Lancefield zone (L1). Collected by W. H. Ferguson, Geol. Surv. Collection No. 18555.

1E.—Distorted polypary (plesiotype) x 2. Obverse aspect. Lancefield, Lancefield (Lower) zone. Geol. Surv. Collection No. 236.

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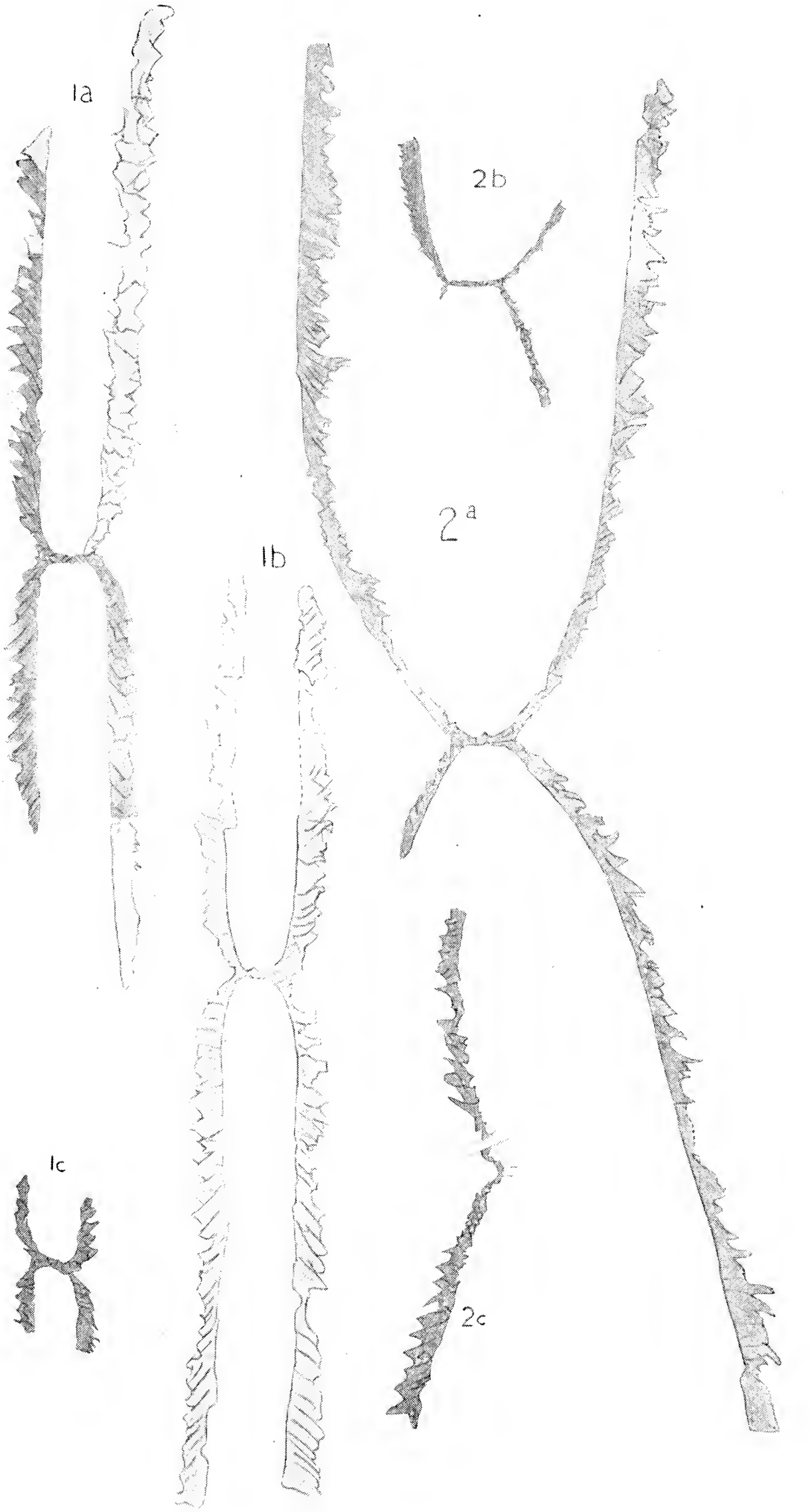
Plate XXXIII.



R. A. Keble, del.

TETRAGRAPTUS.